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GEOLOGY AND THERMAL REGIME,

GEOTHERMAL TEST USA No. 11-36

GRASS VALLEY, NEVADA

for

AMINOIL USA, INC.

Houston, Texas

by

GeothermEx, Inc.
Berkeley, California

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August 1980

DISCLAIMER

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CONTENTS

APPENDIX

ILLUSTRATIONS

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INTRODUCTION

This report summarizes the results of drilling of an 8,565 foot geothermal test near Leach Hot Springs, Pershing County, Nevada, by Sunoco Energy Development Company. USA #11-36 is located 500 feet south and 500 feet east of the northwest corner of Section 36, T. 32 N., R. 38 E (Mount Diablo Meridian), elevation 4,573 feet. It was drilled between May 15 and July 2, 1980. The drilling contractor was R. B. Montgomery Drilling Company. Walter R. Wilde of GeothermEx, Inc. served as well-site geologist and was on location continuously from May 25 to July 1.

USA #11-36 was deemed unsuccessful, having encountered no temperature higher than 270°F and no significant permeability, and was plugged and abandoned without testing prior to releasing the rig. Available logs are listed in table 1. A detailed lithologic log and a complete set of temperature logs are included in appendices A and B of this report. The lithologic and temperature data, penetration history, and casing program are displayed graphically in plate 1.

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Table 1. Logs available for USA #11-36.

Log	Depth	Vertical Scale
Mud log	surface to 8,565 feet	2"/100 feet
Dual induction focused/bore-hole compensated sonic	2,705 to 8,561 feet	2"/100 feet (linear scale) 5"/100 feet (log scale)
Compensated formation density/ compensated neutron	2,705 to 8,561 feet (gamma log to surface)	2"/100 feet 5"/100 feet

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GEOLOGY AND PRE-DRILLING PROSPECT MODEL

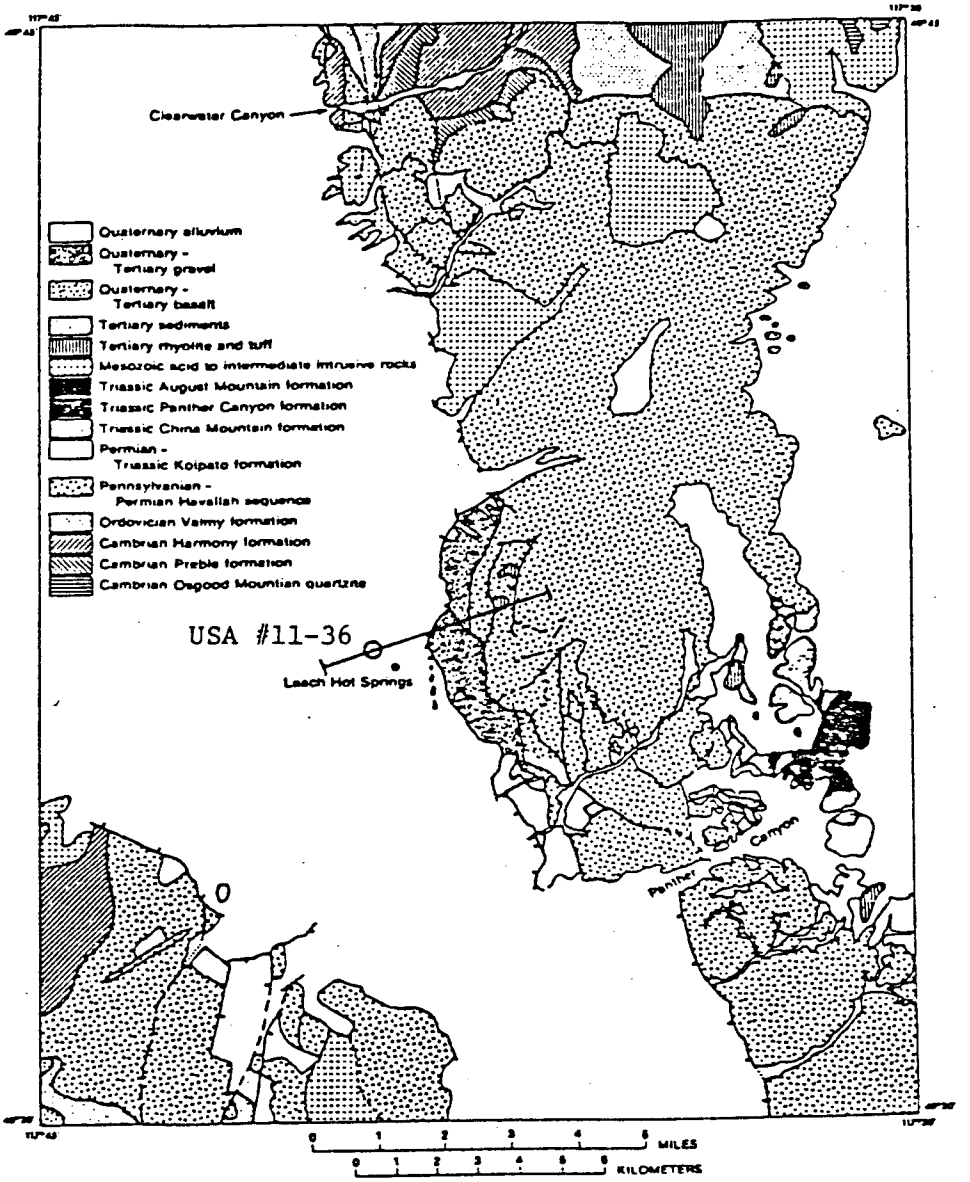
The Leach Hot Springs geothermal prospect has been the focus of extensive geological, geochemical, geophysical and hydrologic investigations conducted by staff of the U. S. Geological Survey and the Lawrence Berkeley Laboratory of the University of California. The results are available in numerous publications; useful summaries are provided by Olmstead and others (1975), Beyer and others (1976), and Sass and others (1977). Only a brief outline of important features is given here.

Leach Hot Springs issue from the base of a fault scarp in alluvium about 1-1/2 miles west of the front of the southern Sonoma Range in Grass Valley, Nevada. Temperatures at various orifices range from 35°C to 90°C (Olmstead and others, 1975). Silica concentration in the thermal water (Mariner and others, 1974) suggests an equilibration temperature at depth of 155°C (311°F). A near-circular heat-flow anomaly about 2 miles in diameter is centered at the springs.

Pre-Tertiary basement rocks exposed in the Sonoma Range (figure 1) in the vicinity of the springs consist primarily of quartzite, chert, greenstone, and argillite of the Permian-Pennsylvanian Havallah sequence. This unit is sometimes subdivided into the Pumpernickel and Havallah formations, based principally on the relative abundance of greenstone, but the lithologies are otherwise similar, and structural and stratigraphic relations are often so complex that considerable question remains as to the validity of the two-formation hypothesis. Several miles south of Leach Hot Springs the Paleozoic rocks are unconformably overlain by silicic pyroclastic rocks of the Triassic (Johnson, 1977) Koipato group. Ten miles north of the springs the Havallah sequence is in complex thrust-fault juxtaposition with Cambrian rocks consisting of quartzite, shale, sandstone, and chert (the Osgood Mountain, Preble, and Harmony formations) and Orodovician argillite, quartzite and greenstone (the Valmy formation). Across the valley in the East Range and the Goldbanks Hills, pre-Tertiary rocks consist of the Havallah sequence and Koipato group, with overthrusts in the Spaulding Canyon area of the Harmony and Valmy formations.

The Paleozoic and Mesozoic rocks are intruded by Mesozoic granitic plutons. Most of these are Jurassic granodiorites. An older group of intrusions, widely associated with the Triassic Koipato group, are largely leucogranites.

Tertiary rocks are poorly exposed in the Grass Valley area. Isolated, widely scattered outcrops of rhyolite tuff in the Sonoma



BEDROCK GEOLOGIC MAP OF LEACH HOT SPRINGS QUADRANGLE, NEVADA

XBL 779-1598

Figure 1

Range and the Goldbanks Hills probably are the oldest. Tertiary sediments consisting of tuffaceous sandstone and siltstone, mudstone, marl, and fresh-water limestone crop out in piedmont fault scarps in front of the Sonoma Range, capped by old alluvial gravels, and at higher elevations in the Goldbanks Hills, where they are overlain by younger basalt flows. A basalt dike crops out in the low mounds on the valley floor south and east of Leach Hot Springs.

Surface fault scarps are numerous on the east side of Grass Valley. A photogeologic structural interpretation (figure 2) by Noble (1975) revealed three sets of surface fault lineations in the valley: (1) a north-south set paralleling the range front; (2) a north-northwest-trending set in the center of the valley; and (3) a northeast-trending set through the hot springs area. The hot springs occur in an area of intersection between north-trending and northeast-trending faults, and it was believed that the geothermal reservoir was within fractured basement rocks associated with these faults at depth. The well location was chosen with an aim to intercept the fault system at a depth of 6,000 to 8,000 feet.

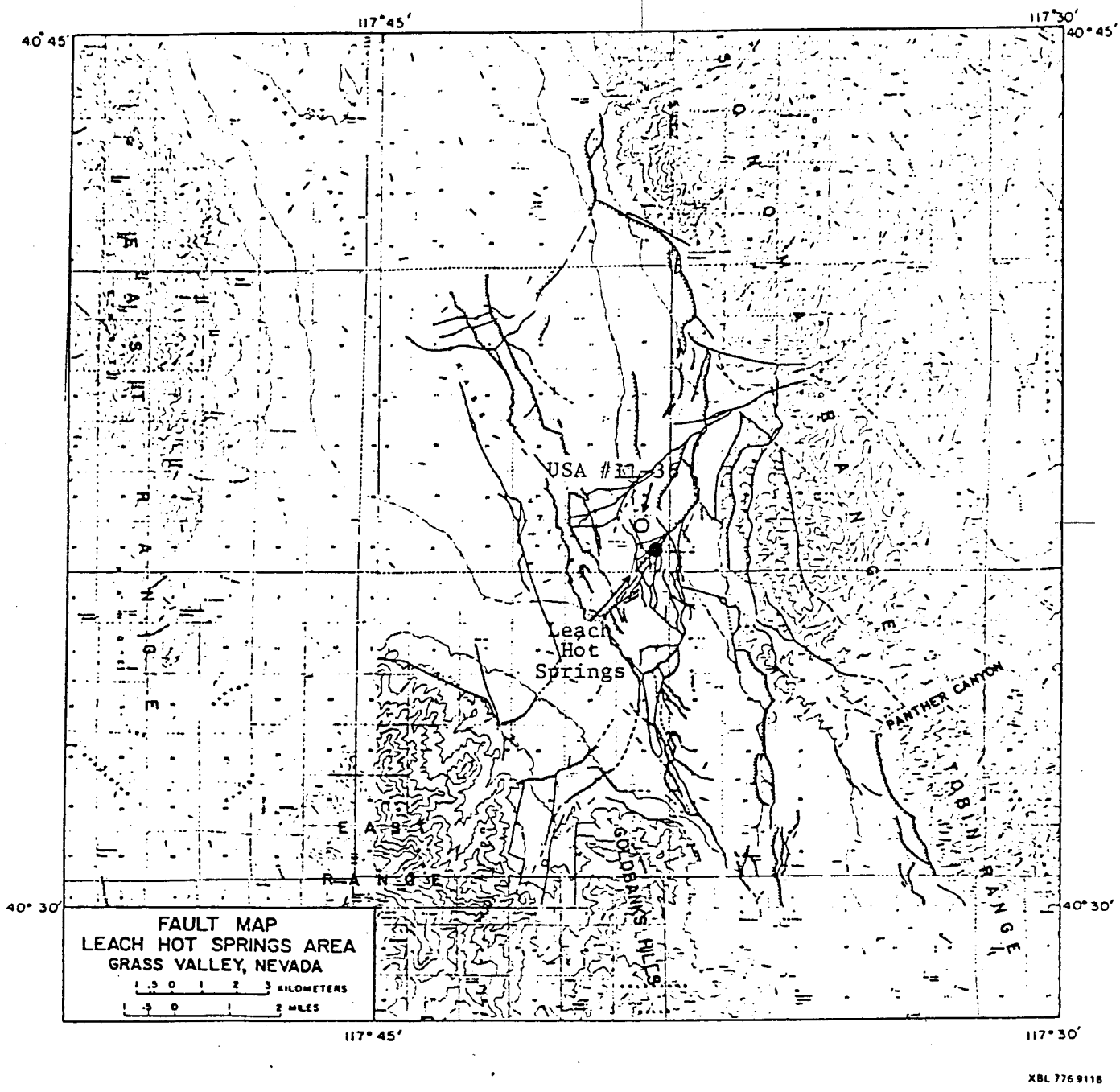


Figure 2. Fault map of the Leach Hot Springs area. Hachured lines indicate down-faulted sides of scarplets; ball symbol indicates downthrown side of other faults. Leach Hot Springs is denoted by a small circle near the center of the map, and Hot Springs passes through it to the northeast and southwest.

OPERATIONAL SUMMARY

The upper part of the well was drilled very rapidly. Spudded at 7:00 PM on May 15, the hole was already 2,900 feet deep when the well-site geologist arrived on May 25. Twenty-inch and 13-3/8-inch casing had been set and cemented at 320 and 2,701 feet respectively. Drilling continued at rapid rates (200 to 400 feet per day) through several formation changes to a depth of nearly 6,000 feet. During this time there were no major drilling problems. At a depth of 5,150 feet, with mud temperatures running about 145°F, a cooler was installed in the mud system.

At 5,963 feet a twist-off in the bottom-hole assembly caused a short delay. This coincided approximately with a significant formation change which slowed drilling thereafter to 100 to 150 feet per day. Drilling proceeded at this slow rate to total depth (8,565 feet) with no notable difficulties. Total depth was reached at 10:00 PM on June 28. Bottoms-up mud circulation (1-1/2 hours) was followed by a short wiper run to condition the hole for temperature logging. The bit was back on bottom at 4:50 AM, June 29, and mud was circulated there for 4 hours, waiting on logging personnel. The final bottom-hole sequence thus consisted of 1-1/2 hours of circulation, followed by approximately 5-1/2 hours of static time (during the wiper run), followed by another 4 hours of circulation.

All temperature logs were made with a newly calibrated Amerada-type down-hole-recording bomb. The first log, consisting of twelve 10-minute stops from 5,000 feet to total depth, came off bottom at 3:50 PM the same day, 7 hours after last circulation. The recorded bottom-hole temperature of 217°F was so unexpectedly low that a decision was made to run two instruments in tandem on the next run to check the instrument accuracy.

Unfortunately, the wire line parted as the two instruments were being withdrawn from the hole on the second attempt. They were eventually fished from near the bottom of the hole with a spear mounted on the end of the drill pipe. The charts indicated that the instruments had stuck in the hole on the way down (apparently they were later knocked to the bottom of the hole by the fishing tools) and gave no reasonable temperature profile for the well. However, a bottom-hole reading of 236°F was obtained from the maximum deflection of the styluses at the end of the charts. The two instruments agreed well, thus substantiating the earlier temperature measurements.

Compensated formation density-neutron and dual induction-sonic logs were run on July 29 and 30 following the aborted temperature log.

Thereafter, on July 30, another temperature log identical to the first was successfully completed. A bottom-hole temperature of 255°F was obtained, representing a warm-up time of 51-1/2 hours. At this time it was decided to plug and abandon the hole, but prior to completion one additional temperature log was run, this one a continuous traverse at 20 feet/minute from 500 feet to total depth. This was finished in the early hours of July 1, giving a final bottom-hole temperature (actually 40 feet off bottom), after 89 hours of shut-in, of 258°F. Cementers were called in then to set plugs in preparation for abandonment.

In the course of drilling USA #11-36 no gases were detected in the mud system and only one demonstrable mud loss occurred. This was at 7,137 feet, where a total of 50 bbl of mud was taken by the formation over a two-hour period. The initial rate of 60 bbl/hr fell off quickly to low levels. Other slow losses (and sometimes gains) were suspected from time to time, based primarily on anomalous changes in mud properties, but were never adequately substantiated. Continuous and variable mud-volume changes caused by (1) removal of mud by desilters, (2) loss of mud over shakers, (3) periodic cleaning of mud pits, and (4) intermittent additions of water to make up for mud losses, made it difficult to detect low-level mud losses. Special arrangements had to be made between the mud logger and the derrick hand to check suspected losses. One such loss of 3 to 5 bbl/hr between 8,150 and 8,200 coincides with an anomalous low-resistivity zone in the dual-induction log and may be real. It is possible that other losses (or gains) up to 5 bbl/hr went unnoticed.

DESCRIPTION OF LITHOLOGIES

USA #11-36 was collared in alluvium approximately 2 miles from the lowest bedrock outcrops in the Sonoma Range. Soft, poorly sorted, tan-colored sediments were drilled for the first 1,400 feet. In the upper 100 feet the clay-rich matrix is very calcareous. Between 100 and 600 feet the sediments are variably silicified, with silica typically forming rounded, glassy coatings on sand and gravel clasts rather than discrete quartz crystals. Silicified alluvium usually contains tubular passageways through which mineralized water, presumably subsurface outflow from nearby Leach Hot Springs, moved.

Below 1,400 feet the sediments gradually become better consolidated. Large intervals are predominantly calcareous siltstone, mudstone, and claystone, deposited apparently under lacustrine conditions. These tend to be colored greenish rather than tan as is the shallow alluvium and often they contain disseminated pyrite and embedded euhedral calcite crystals of questionable origin. Other intervals contain abundant sand and gravel as well as fine-grained sediments. Tuffaceous material appears in the sediments at around 3,250 feet, increasing irregularly over the next 150 feet to prominent tuffaceous sandstone, siltstone, and conglomerate beds between 3,390 and 3,450 feet. Below this, most of the sandy and gravelly sediments are tuffaceous in some degree, but large intervals still consist mainly of greenish mudstone and claystone. Between 4,300 and 4,775 feet, the sediments consist almost entirely of tuffaceous sediment.

The transition from Tertiary/Quaternary valley-fill sediments to older Tertiary sediments, like those which crop out in fault scarps northeast and southeast of Leach Hot Springs, is not clearly defined in the valley subsurface. There may in fact be no unconformity between the two sedimentary sequences; the old sedimentary basin was not necessarily destroyed in entirety by uplift of the Sonoma and East Ranges.

At 4,775 feet the hole passed abruptly into volcanic flow rocks. These are predominantly mafic lavas (basalt and/or andesite) which contain phenocrysts of feldspar and a mafic mineral (pyroxene?). Alteration has destroyed much of the original texture and converted most of the primary minerals to chlorite and clay. At least one flow of more silicic composition (dacite or rhyodacite) is included in the sequence. A basal zone between 4,980 and 5,025 feet yielded texturally heterogeneous volcanic cuttings of mafic composition, along with minor amounts of miscellaneous other rock fragments. This may be a rubble zone associated with the earliest eruptions of mafic magma.

Below 5,025 feet are silicic tuffs and tuffaceous sediments of highly variable character. Sampling resolution was inadequate for division of these rocks into distinct subunits. Cuttings from this interval consist of nearly random proportions of silicic tuff fragments (variable texture, color, and composition), lithic fragments (mostly chert and/or cryptocrystalline rhyolite), and claystone and mudstone virtually identical to that which makes up much of the section above the volcanic flow rocks. Much of the claystone and mudstone was initially interpreted as slough, but its persistence in large quantities (up to 60% of some samples) over several hundred feet contradicted this assumption. Electrical logs indicate abundant clay-rich material between 5,200 and 5,320 feet. Evidently a stable lacustrine sedimentary environment persisted throughout the period of deposition of the Tertiary volcanic and sedimentary rocks. Variable supply of coarse-grained detritus (much of it possibly subaerial fall-out from volcanic eruptions) apparently was the main determinant of rock character. The volcanic flows may have accumulated underwater, which could explain their pervasive chlorite/clay alteration.

White cryptocrystalline rhyolitic rocks were encountered at 5,330 feet. The upper portion of this unit is weathered and iron-stained to a depth of nearly 100 feet. Red-brown fine-grained hematite crystals and a similarly textured yellow vitreous mineral (goethite?) line many small cavities produced by weathering. Minor amounts of very dark red-brown clay-rich material (as much as 10 percent of some samples) is present within the weathered rhyolitic rock, possibly crack filling or highly oxidized gouge in small shear planes. At about 5,420 feet the amount of iron staining decreases significantly, but some oxidation effects are noted throughout the unit. Because of the intense weathering in the upper part of the unit, lengthy surface exposure must be postulated prior to burial by the tuffaceous sediments. Petrologic similarity between the rhyolitic rocks and nearby outcrops of the Koipato formation suggests that the interface is a major unconformity separating the Tertiary and Triassic Periods.

The rhyolitic unit is not uniform from top to bottom. Some intervals are characterized by variable colors and textures which suggest a sedimentary origin. Fragments of other lithologies are present in the samples, and although these could be in part sloughed from overlying sedimentary strata, some may be derived from lithic tuffs within the rhyolitic unit. Other intervals are internally homogeneous and contain sparse altered phenocrysts of mica and feldspar. They may in part be rhyolitic porphyry intrusions (recognized elsewhere within the Koipato formation), but some fragments are banded, suggesting an extrusive origin. No mafic minerals of any kind are presently detectable, although the sericitized mica phenocrysts may have been originally biotite. Pyrite is disseminated in trace amounts.

Beginning at 5,690 feet, the rock shows subtle signs of alteration to a crypto-crystalline to microcrystalline pale brown material with a greasy luster, a characteristic which continues with increasing intensity to the basal contact with granite at 5,720 feet. The most intensely recrystallized material resembles pearly sericite. Most likely, the alteration is due to contact metamorphism by the intruding granite magma.

The granite, a very light-colored fine-grained rock consisting almost entirely of feldspar (partly kaolinized), quartz, and mica (various shades of green and brown), persisted only to 5,850 feet, giving way to altered volcanic rocks across a contact of uncertain nature. The volcanic rocks below the granite show wide variability in their degree of recrystallization, ranging from nearly fresh basalt or andesite to completely recrystallized biotite-hornblende-epidote-calcite rock. Interspersed with these fragments are abundant microgranular quartz-feldspar-biotite-muscovite-chlorite aggregates (mineral proportions variable) and occasional sericite. This material does not appear to occur in discrete dikes, but as an alteration of the volcanic rocks. Some fragments are obviously sheared, but major faulting probably has not taken place.

Within a few tens of feet of the granite contact, relict volcanic textures die out completely. For the ensuing 1,300 feet the rocks consist entirely of heterogeneous aggregates of about five major minerals and as many accessory minerals in widely varying proportions. The major minerals are identical to those associated with alterations in the contact zone, namely quartz, feldspar, biotite, chlorite, and muscovite. Accessory minerals are tourmaline, epidote, magnetite, pyrite, and possibly one or more zeolite minerals. Kaolinite is a widespread younger(?) alteration mineral. Textures are extremely erratic in most samples, usually massive to splotchy or streaky, occasionally schistose. Grain size is very fine on the average, but also varies widely. Often wide textural variations are present within individual cuttings, sometimes with a sharp interface, but just as often with a gradational one. Mineral proportions fluctuate to extremes as well.

Quartz is the most abundant mineral overall and also displays the greatest range of textures. Some cuttings fragments consist of almost pure granoblastic quartz, although most often quartz is intergrown with crystals of the other major minerals. Large crystals of quartz often are embedded within otherwise very fine-grained aggregates of other minerals. In some cases the coarse-grained quartz forms discrete veins within the rock. Tourmaline is commonly intergrown with vein quartz in some intervals, as are coarse-grained muscovite and feldspar in others. Drusy quartz also lines sparse cavities throughout this

unit. These varied modes of occurrence of quartz, so different from those of other minerals, give the distinct impression that most of the silica has been introduced into the rock from outside. The unusual association with mafic volcanic rocks in the interval immediately below the granite contact suggests this also.

Superimposed upon this formidable short-range heterogeneity, there are long-range compositional variations that span tens to hundreds of feet. These are noted primarily in the overall percentage of the dark-colored minerals, chlorite and biotite. Other changes may be involved as well, but are not as easily discernable in the midst of so much random heterogeneity. The broad compositional variations may be related to differences in parent material, but because there apparently has been widespread chemical redistribution, the variations could well be caused by secondary processes as well.

Occasional stray fragments of mafic volcanic rocks are seen in samples of this highly recrystallized material. The quantities generally are so insignificant that they are easily explained as slough from higher in the hole. However, beginning at 7,180 feet a substantial portion of many samples is made up of recognizable mafic volcanic fragments obviously in place. These rocks have clearly undergone alteration by (1) instense leaching of Fe and Mg (bleaching), (2) recrystallization to fine-grained chlorite, muscovite, feldspar, epidote, and possibly zeolite, (3) impregnation with silica, and (4) growth of tourmaline. In other words, the alteration is to material very similar to that drilled in the preceding 1,300 feet of hole. Much of this material has been kaolinized, as above.

The section between 7,180 and 7,300 feet is made up of widely varying porportions of altered and unaltered volcanic rocks. Most of the volcanic rocks are mafic in composition, but a white, banded, cryptocrystalline tuff of silicic composition makes up as much as 40% of samples between 7,260 and 7,290 feet. Toward the bottom of this interval, alteration becomes progressively sericitic in character. Many fragments near the basal contact consist entirely of extremely fine-grained, occasionally schistose aggregates of muscovite and chlorite.

From 7,310 to 7,395 feet, drilling was within fresh diabase. This was to be the first of a series of five similar mafic intrusions of varying thickness which were penetrated within 1,000 feet. The term diabase is used for these rocks throughout the logs for the sake of simplicity, but diabasic texture is not always well developed. The margins of the intrusions are aphanitic, and grain size increases symmetrically inward to fine- to coarse-grained cores, depending on the thickness of the intrusion. Plagioclase feldspar (labradorite) and black

pyroxene make up the bulk of the rock. Magnetite is very abundant also. The only other distinguishable phase is a subhedral reddish brown accessory mineral, possibly rutile. Large phenocrysts of plagioclase (up to 5 mm) are present in some of the intrusions. These typically contain fine, elongate, black inclusions oriented parallel to the crystal faces. Locally, the diabase is fractured, and soft fine-grained greenish to black material, possibly serpentine, is developed within the fracture planes. Although this material often is slickensided, there does not appear to have been any major faulting involved.

The lower boundary of the first diabase intrusion may have been intersected at a low angle by the borehole. Ten percent of the sample at 7,380 feet consists of coarse-grained quartz-feldspar rock. Gradually over the next 40 feet the quartz-feldspar fraction increases to 95%. Biotite makes a first appearance at 7,420 feet. Magnetite also appears in tiny interstitial grains. These four minerals (quartz, feldspar, biotite, and magnetite) constitute the primary mineral assemblage of a granitic body which was drilled to a depth of about 8,000 feet. Secondary minerals, including muscovite, epidote, chlorite, kaolinite, pyrite, calcite, and possibly zeolite, are widespread. Chlorite, epidote, and pyrite all are spatially associated with biotite, and presumably formed by reaction with it. The other minerals appear to have recrystallized from primary feldspar. Tourmaline is locally present also, but always is intergrown with coarse-grained, slightly milky quartz, probably in late-stage veins.

The granitic texture is often indistinct because of the pervasive alteration. Usually it has a "shattered" or microbrecciated appearance, which may be caused by cooling stresses or to incipient alteration along cleavage cracks. Alteration to secondary minerals occurs throughout the granite, but it is never so intense that it completely consumes the primary minerals. It appears to have resulted from the action of late-stage deuteric fluids rather than by post magmatic metamorphic or hydrothermal processes. The presence of tourmaline-bearing quartz veins within the granite provides evidence for the existence of late-stage volatile-rich fluids.

The granite is intruded by diabase (the largest of the five diabase bodies) between 7,525 and 7,685 feet (depths from density and gamma-ray logs which are offset about 10 feet from the lithologic logs). At 8,000 feet there is a conspicuous increase in the biotite content of the granite, accompanied by increased muscovite alteration of feldspar grains. Over the next 40 feet biotite at first continues to increase dramatically, but this progression is overtaken and masked by increasingly intense alteration similar to that in volcanic rocks above the first

diabase dike. The end result (typified by the sample at 8,030 feet) is a heterogeneous, variably textured, streaky, crumbly, micaceous fine-grained rock with abundant quartz (plus tourmaline, plus feldspar) streaks and/or veins, and no relict texture.

The altered rock is intruded at 8,050 feet (depth from the logs) by a third diabase dike, this one only about 60 feet thick. Once again, the upper contact is abrupt, while the lower transition spans about 40 feet of depth, indicating possibly a near-vertical orientation. Rocks immediately below the contact are virtually identical to those immediately above, but at 8,120 feet coarse, disaggregated biotite flakes are present in the sample. With depth, the amount of biotite increases gradually, and an association with greenish black hornblende becomes clear, while the amount of fine-grained micaceous alteration and quartz veining fluctuates.

A fourth diabase dike between 8,150 and 8,170 feet is sharply defined in the gamma-ray log, but samples in this region contained only 30% diabase. This intrusion coincides with a country-rock transition from highly altered material described above to a relatively homogeneous and unaltered biotite amphibolite containing both black hornblende and green actinolite as major amphibole phases, minor interstitial feldspar, trace calcite, and minor chloritic alteration.

A thin diabase dike was penetrated at around 8,250 feet, but its exact depth is not well resolved by either the lithologic log or the down-hole geophysical logs. It is followed by one more highly altered interval of about 10 feet. Below this, biotite amphibolite resumes, but the primary amphibole from this point on is actinolite. The bottom 300 feet of rock penetrated seems to be compositionally homogeneous, but the degree of recrystallization varies. Well recrystallized facies are deep gray-green and have a well-defined texture in which individual bladed crystals of actinolite are easily distinguishable. At the other extreme, distinguishable biotite crystals are separated by black aphanitic material which appears, from occasional indistinct cleavage reflections, to be proto-amphibole. This material usually contains much magnetite. All gradations between these extremes are present, often within individual samples. Traces of waxy talc-like sheared material are present in nearly all of the samples, becoming more abundant in the bottom 100 feet. Light-greenish clay alteration is similarly distributed.

Figure 5 is a hypothetical cross-section through USA #11-36 showing possible relations in the subsurface of the various lithologic units. The line of the section line is shown in figure 1.

THERMAL REGIME

Temperature data for USA #11-36 are displayed in figure 3 and plate 1. These include mud temperatures, bottom-hole temperatures measured with maximum-reading thermometers (MRTs) during directional surveys, and three Kuster temperature surveys taken at total depth, the last of which was a continuous traverse at 20 feet/minute from 500 feet. The highest recorded temperature was 258°F at the end of the third temperature survey, 40 feet off bottom, 89 hours after last circulation of drilling mud. An equilibrium temperature profile was not obtained prior to abandonment.

Mud temperatures increased rather steadily for the first 5,000 feet. At 5,150 feet the mud chiller was activated, which caused an immediate 20°F drop in the flow-line temperature (and a wider separation between the "in" and "out" temperatures). Because of variable cooling efficiency, mud temperatures fluctuated much more widely with the mud chiller in operation. However, on the average mud temperatures continued to increase to total depth. The highest recorded mud temperature was 167°F, recorded at 8,270 feet with the cooler off for nearly 24 hours beforehand. The final flow-line temperature at total depth (with the chiller on) was 143°F.

Bottom-hole MRT readings increased with depth at a substantially greater rate than the flowing mud temperature. A similar effect has been noted in other wells, even some which were essentially isothermal over large intervals. It may be due to both (1) increasing discrepancy with depth between the bottom-hole and surface flowing mud temperatures, caused by the longer round-trip circulation time, and (2) pressure effects on maximum-reading thermometers which increase with depth. In USA #11-36 the bottom-hole MRT temperatures project to temperatures at total depth which are higher than those measured on the first Kuster survey conducted 7 hours after last circulation. Because several hours of circulation on bottom preceded the temperature logging (compared to about 10 minutes prior to directional surveys), the presumed pressure effect is debatable.

A temperature build-up curve on bottom is plotted (figure 4) using the bottom-hole temperatures from the first two temperature logs, the projected bottom-hole temperature from the third (continuous) log, and the 236°F maximum temperature read from the instruments which had been accidentally dropped and later recovered from the bottom of the hole (between temperature logs #1 and #2). Because of complexity of the hole-conditioning procedures after total depth was reached, a proper Horner plot cannot be made. However, a reasonable Horner-type extrapolation can be made by assuming that the 5-1/2 hours of circulation and

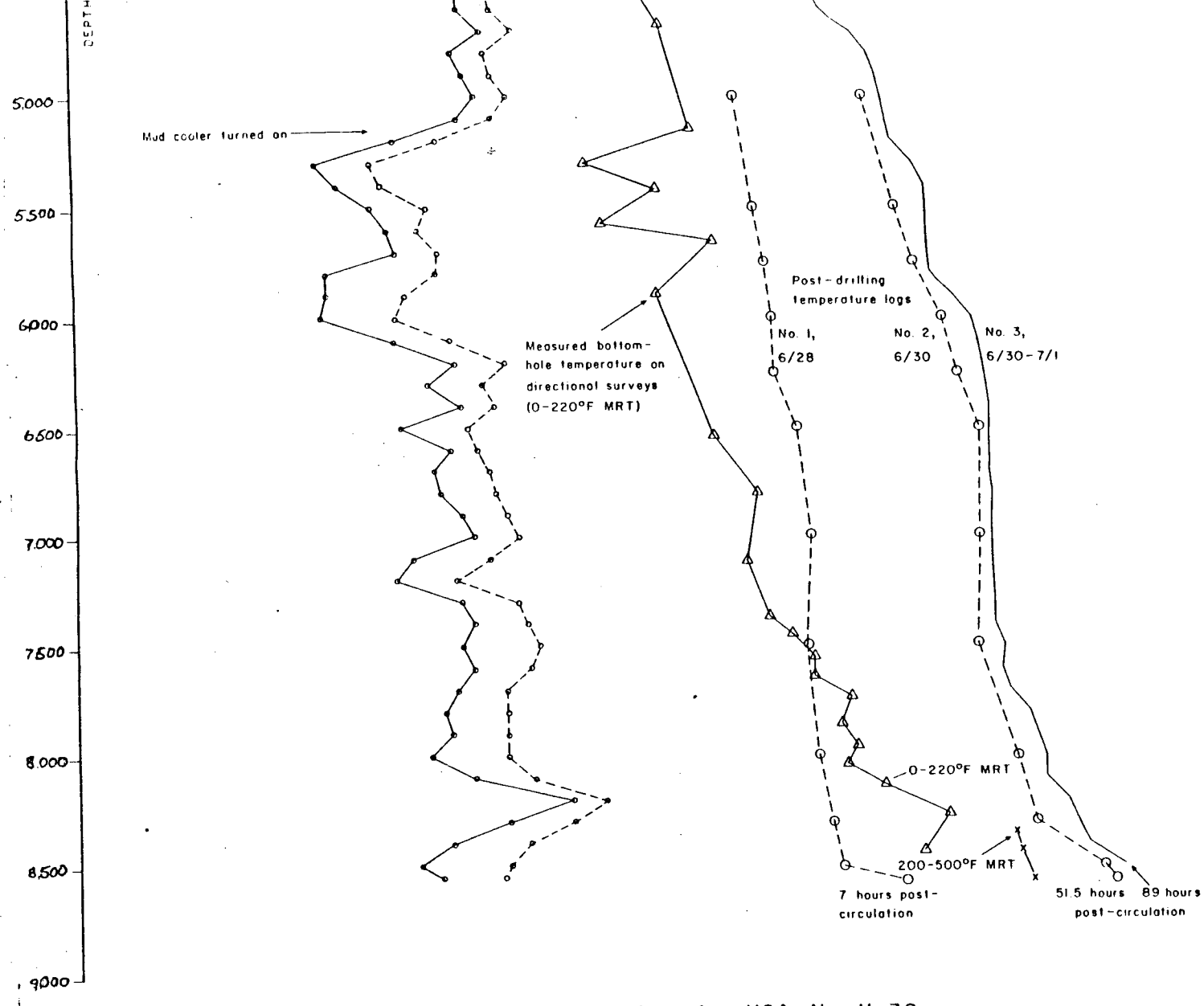
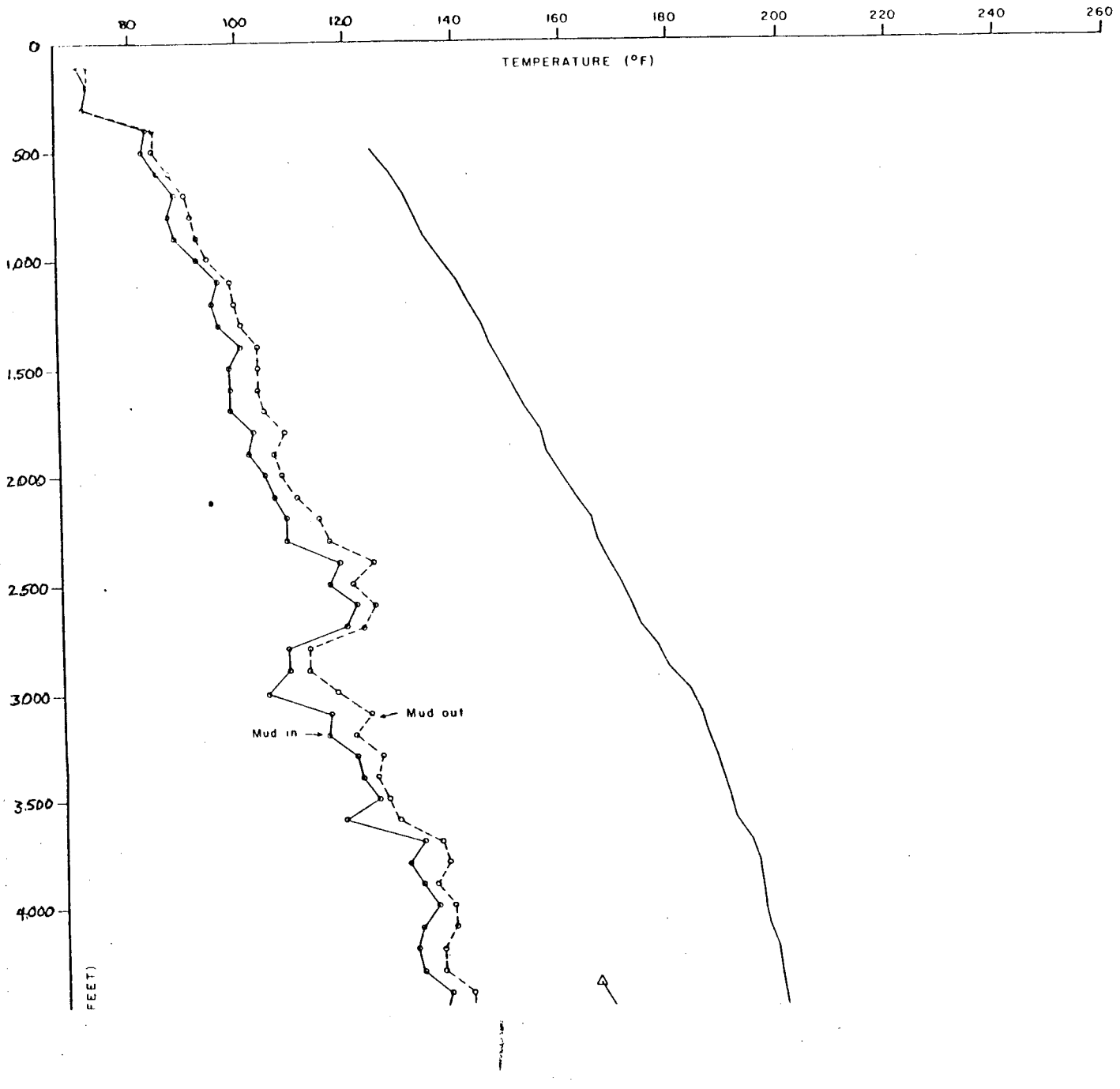


FIGURE 3. Temperature data for USA No. 11-36.


80
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200
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240
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1,500
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FEET)
Mud out
Mud in

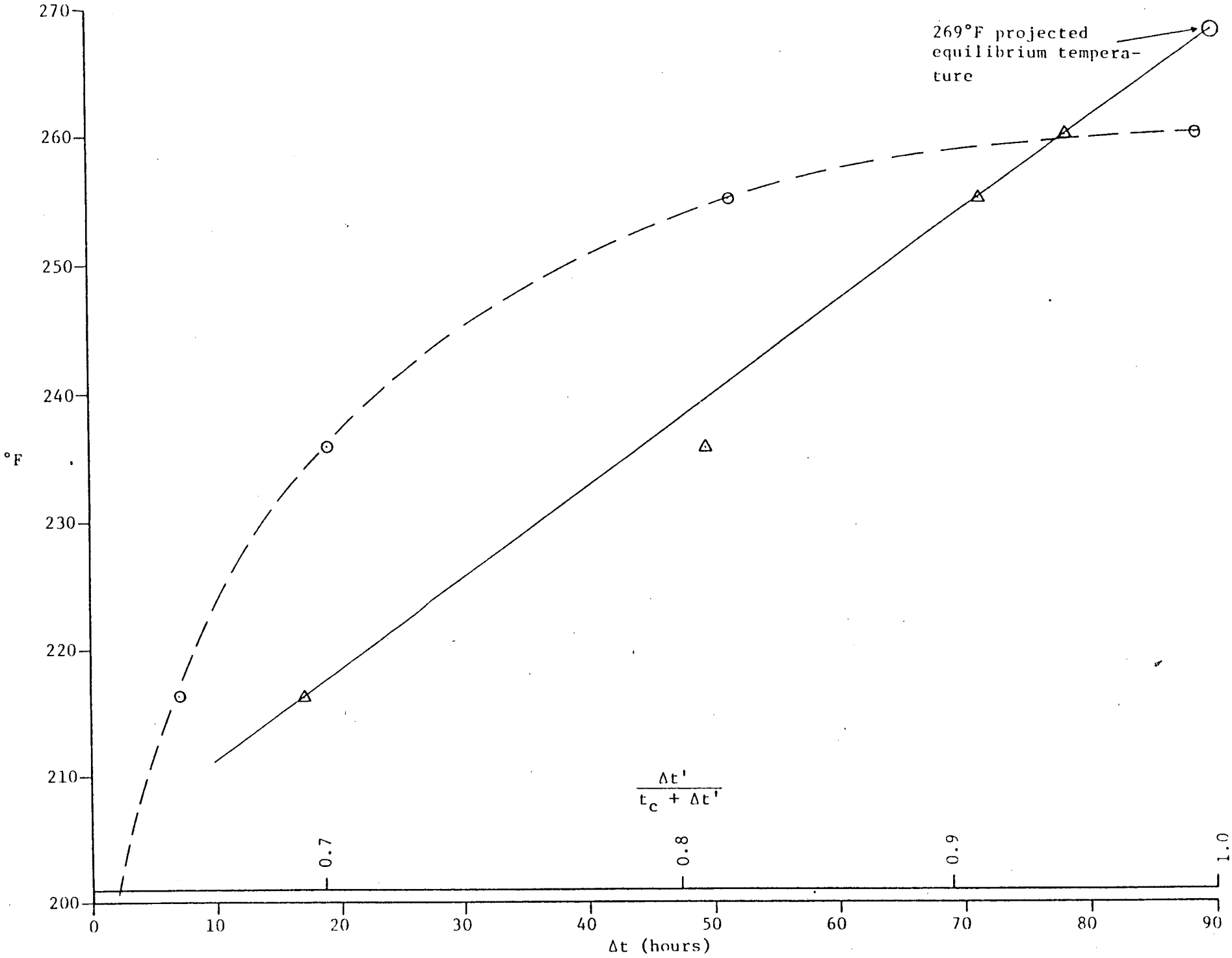

FIGURE 4. Bottom-hole temperature build-up curve (dashed line) and Horner plot (solid line) for USA #11-36 ($\Delta t'$ = Δt + 5-1/2 hours; t_c = 5-1/2 hours)

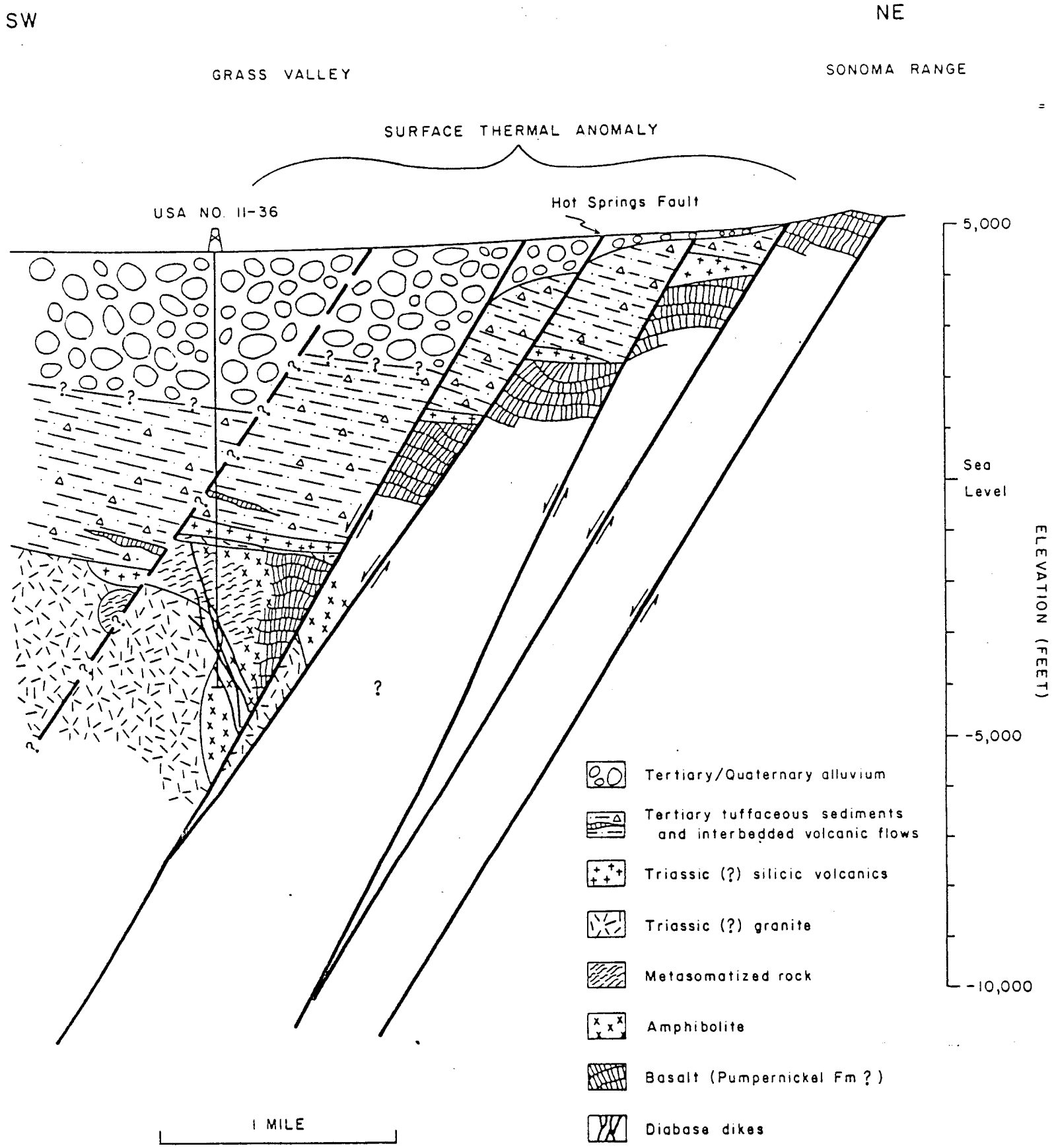

FIGURE 5. Hypothetical cross-section through USA No. 11-36. Line of section shown in figure 1.

5-1/2 hours of trip time occurred sequentially prior to logging. Thus $\Delta t'$ (total shut-in time) = Δt (time since last circulation) + 5-1/2 hours, and t_c (circulation time at total depth) = 5-1/2 hours. When the simulated Horner plot is drawn using these parameters (figure 4), a bottom-hole equilibrium temperature close to 270°F is obtained. This value is probably accurate to ±5°F. The maximum temperature on the aborted temperature log between runs #1 and #2 is several degrees lower than the straight line through the other values, possibly indicating that the instruments did not fall all the way to bottom.

The extrapolated 270°F equilibrium temperature is significantly lower than the geochemically inferred minimum reservoir temperature for the Leach Hot Springs water, and indeed is only 75° higher than the surface orifice temperature. Clearly, the well missed its objective of intercepting the main circulation system for the Springs. Unfortunately, owing to the lack of an equilibrium temperature profile, it is impossible to determine on the basis of temperature logs whether the well entered any convective system. Other evidence is equivocal. Recent hydrothermal alteration is difficult to distinguish from the chemical and mineralogical heterogeneity which characterizes much of the bedrock. Traces of drusy quartz are present throughout the hole, even to some extent within the Cenozoic sediments, but its age(s) and possible relations to the present thermal regime are conjectural. No strong evidence of large-scale Cenozoic faulting was observed. Circulation losses during drilling were minor.

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Appendix A

Detailed Lithologic Log for USA #11-36

LITHOLOGIC LOG

Depth Interval, Feet	
60-	90 SAND & GRAVEL, varicolored clasts, angular to round, predominately of silicic metasediments and granite, in tan colored fine-grained, very calcitic matrix, trace vitric quartz cement and fracture filling with round surfaces.
90-	120 a/a; calcareous cement has "tubes," vugs lined with sparry crystals
120-	150 a/a; some clasts very light gray fine-grained silicified tuff
150-	180 a/a; silty matrix not calcareous; no visible quartz cement, only occasional thin vug lining; trace rhyolite tuff clasts
180-	210 SAND & GRAVEL; varicolored angular to subrounded clasts predominately of silicified metasediments and granite in tan-colored silty clay non-calcareous matrix
210-	240 a/a
240-	270 a/a
270-	300 a/a; matrix silicified with glassy silica (no crystal faces, even within vugs)
300-	310 a/a; matrix silicified; some vugs filled with calcite
310-	325 a/a; 60% sandy SILTSTONE "matrix," light brown, silicified in part with common "tube" structure; some vugs lined with dark brown vitreous mineral, others with calcite; 40% SAND & GRAVEL
325-	360 a/a
360-	390 a/a; occasional vugs and tubes in silty matrix with whitish reaction rim; some light grey rhyolite tuff fragments
390-	420 Sandy, muddy SILT, light brown, subrounded to round clasts of silicified metasediments, tuffs; partly silicified; common tube structure with associated whitish alteration of host; occasional chalcedony veins
420-	450 a/a; decrease silicification; trace opalitization of clay-rich matrix

450- 480	a/a; decrease silicification; trace opalitization of clay-rich matrix; sample contains only 10% sand and gravel clasts
480- 510	a/a
510- 540	a/a; minor silicification, common tube structure
540- 570	SAND & GRAVEL, light brown non-calcareous silty clay matrix, angular to subrounded clasts of silicified metasediments; trace silicification
570- 600	a/a; 40% clasts, 60% light brown "matrix," no silicification
600- 630	a/a; Note: poorly washed sample.
630- 660	a/a; no silicification
660- 690	SAND & GRAVEL, light brown non-calcareous silty clay matrix, subrounded to round clasts of silicified metasediments; poorly consolidated
690- 720	a/a
720- 750	a/a; decrease clay content of matrix; very poorly consolidated
750- 780	a/a; very poorly consolidated
780- 810	a/a; very poorly consolidated
810- 840	a/a; very poorly consolidated
840- 870	a/a; very poorly consolidated
870- 900	no sample
900- 930	a/a; very poorly consolidated
930- 960	sandy, gravelly SILT, light brown, calcareous, very poorly consolidated
960- 990	SAND & GRAVEL, light brown non-calcareous silty matrix, very poorly consolidated; clasts predominantly silicified metasediments
990-1,020	a/a
1,020-1,050	a/a; slightly better consolidation, silty clay matrix
1,050-1,080	a/a; slightly better consolidation, silty calcareous matrix matrix
1,080-1,110	a/a; slightly more consolidation, silty calcareous matrix Note: sample contained abundant black lignite (mud additive)

1,110-1,140	a/a; slightly better consolidated, silty calcareous matrix matrix
1,140-1,170	SAND & GRAVEL, light brown, poorly consolidated, silty calcareous matrix; varicolored angular to subrounded clasts of predominantly silicified metasediments
1,170-1,200	a/a; increase matrix fraction
1,200-1,230	a/a; increase matrix fraction, grades to sandy siltstone; trace silicification
1,230-1,260	a/a; very poorly consolidated
1,260-1,290	a/a; very poorly consolidated
1,290-1,320	a/a; very poorly consolidated
1,320-1,350	a/a
1,350-1,380	Sandy MUDSTONE, light brown, poorly consolidated, calcareous; subangular to subrounded clasts of metasediments, metavolcanics, quartz, granitic rock, trace rhyolite; includes 10% white to buff CLAYSTONE
1,380-1,410	a/a

--top of Ts unit?

1,410-1,440	MUDSTONE, light gray, grades to minor CLAYSTONE and minor sandy MUDSTONE of same color; moderately consolidated; calcareous. Note: Very coarse cuttings (to 3/4")
1,440-1,470	a/a
1,470-1,500	a/a; sample includes 50% sand and gravel clasts, subrounded to round, mostly light-colored silicified metasediments
1,500-1,530	a/a; Note: extremely coarse cuttings (to 1")
1,530-1,560	a/a; sample contains 30% subrounded to round sand and gravel clasts; predominately varicolored silicified metasediments
1,560-1,590	a/a; sample contains 30% subrounded to round sand and gravel clasts, predominately varicolored silicified metasediments; trace flesh-colored clay (devitrified tuff?)
1,590-1,620	a/a; sample contains 50% subangular to subrounded sand and gravel clasts, predominately varicolored silicified metasediments and mafic metavolcanics; poorly consolidated

1,620-1,650	MUDSTONE, light gray, moderately consolidated, calcareous, sandy and gravelly in some parts, with subangular to subrounded clasts of varicolored silicified metasediments.
1,650-1,680	a/a; sample includes 10% coarse sandy clasts
1,680-1,710	a/a
1,710-1,740	a/a; sample includes 20% coarse sand and gravel clasts
1,740-1,770	a/a; sample includes 10% sand and gravel clasts
1,770-1,800	a/a
1,800-1,830	a/a; grades to nearly white calcareous claystone
1,830-1,860	MUDSTONE and CLAYSTONE, light gray (with greenish cast in part) and flesh-colored, calcareous, moderately consolidated; locally with abundant sand and gravel clasts (50% of sample) of varicolored metasediments and metavolcanic rocks; Note: sample contains a fossil shellfish
1,860-1,890	a/a; sample includes 30% sand and gravel clasts; Note: extremely coarse cuttings (mudstone fragments to 1", gravel clasts to 3/4")
1,890-1,920	a/a; subrounded gravel clasts to 3/4"; trace calcareous veins in claystone
1,920-1,950	a/a; sample contains 70% coarse sand and gravel clasts, angular to round, mostly varicolored silicified metasediments
1,950-1,980	a/a; sample contains 80% coarse sand and gravel clasts of siliceous metasediments and minor mafic metavolcanics
1,980-2,010	SAND & GRAVEL, varicolored, poorly sorted, poorly cemented; angular to subangular clasts of varicolored silicified metasediments (includes chert, siltstone, quartzite) and minor dark metavolcanic rocks; trace biotite and quartz; sample includes 10% mudstone and claystone a/a
2,010-2,040	a/a; includes 30% clay-rich sandy and silty matrix
2,040-2,070	a/a; includes 30% clay-rich sandy and silty matrix
2,070-2,100	a/a; 70% sand-sized clasts; 30% light grey to flesh-colored MUDSTONE & CLAYSTONE, locally sandy; probably not all matrix material; possible interbeds

2,100-2,130	60% SAND & GRAVEL clasts, angular to round, varicolored, predominantly metasediments, minor metavolcanics 40% SILTSTONE, MUDSTONE & CLAYSTONE, tan to light gray, locally sandy, slightly calcareous, slight to moderate consolidation; appears to be mostly matrix material for sand and gravel clasts
2,130-2,160	a/a
2,160-2,190	a/a; 80% coarse sand and gravel clasts
2,190-2,220	a/a; 70% corase sand-sized clasts; matrix mostly flesh-colored
2,220-2,250	a/a; 50% sand and gravel clasts
2,250-2,280	a/a; 60% sand and gravel clasts
2,280-2,310	a/a; 30% sand and gravel clasts
2,310-2,340	a/a; 60% sand and gravel clasts
2,340-2,370	a/a; 40% sand and gravel clasts
2,370-2,400	a/a; 70% sand and gravel clasts
2,400-2,430	a/a; 85% sand and gravel clasts
2,430-2,460	a/a; 70% sand and gravel clasts (abundant gravels)
2,460-2,490	a/a; 90% sand and gravel clasts
2,490-2,520	a/a; 80% sand and gravel clasts
2,520-2,550	a/a; 80% sand and gravel clasts
2,550-2,580	a/a; 40% sand and gravel clasts
2,580-2,610	a/a; 20% sand and gravel clasts
2,610-2,640	a/a; 60% sand and gravel clasts
2,640-2,670	a/a; 70% sand and gravel clasts (predominantly fine sand)
2,670-2,705	a/a; 50% sand and gravel clasts (predominantly fine sand)
2,705-2,730	MUDSTONE & CLAYSTONE, predominately light greenish grey, some light brown, moderately consolidated, calcareous; common mica flakes; sample includes 10% subrounded sand and gravel clasts, predominately metasediments; common slickensides with dark green surfaces (possibly due to drill bit?)

2,730-2,760	80% Coarse sand and gravel clasts, predominately light green grey and black, angular to subangular; predominately coarse-grained biotite granite (biotite partly chloritized) and monomineralic feldspar and quartz grains, with lesser dark-colored silicified metasediments; trace vesicular andesite 20% MUDSTONE & CLAYSTONE a/a
2,760-2,790	MUDSTONE, light greenish grey, moderately to well consolidated, calcareous, very uniform.
2,790-2,820	a/a; occasionally slight sandy MUDSTONE; trace slickensides, Note: very coarse cuttings
2,820-2,850	a/a; grades to claystone; trace slickensides
2,850-2,880	CLAYSTONE, light green-gray, moderately to well consolidated, calcareous with abundant dark green slickensides; grades to minor mudstone
2,880-2,910	a/a; 2% sandy clasts; minor slickensides; trace pyrite in clumps
2,910-2,940	CLAYSTONE & MUDSTONE, light gray to light gray-green, moderately to well consolidated, calcareous, trace slickensides; includes 5% sandy clasts; trace pyrite clumps
2,940-2,970	a/a; grades to minor calcareous sandstone; trace zeolite (laumontite?) aggregate
2,970-3,000	MUDSTONE, predominantly light brown, moderately to well consolidated, calcareous, very uniform; trace pyrite clumps
3,000-3,030	a/a; grades to slight greenish claystone; trace slickensides
3,030-3,060	a/a
3,060-3,090	MUDSTONE & CLAYSTONE, predominately light green-gray, grades to light brown, cream, and light gray; predominately well consolidated, calcareous; trace pyrite clumps; trace sand grains; trace slickensides
3,090-3,120	a/a
3,120-3,150	a/a; some sandy MUDSTONE; 3% disagregate sand grains
3,150-3,180	a/a; 5% disaggregate sand grains (granite, metasediments, metavolcanics)
3,180-3,210	70% CLAYSTONE & MUDSTONE, light green-gray to light red-brown, moderately to well consolidated, slightly calcareous, occasionally sandy; trace slickensides

30% disaggregate medium to coarse sand clasts, predominately subangular, predominately metasediments and granite with abundant dark purple-brown stain (weathered surface?)

3,210-3,240 CLAYSTONE & MUDSTONE, predominately light green-gray, grades to minor light brown and white, moderately to well consolidated, slightly calcareous, occasionally sandy and mica-rich; trace slickensides with dark green coating; includes 5% disaggregate sand grains with abundant dark purple-brown weathering(?) stain

3,240-3,270 a/a; 20% disaggregate sand grains

3,270-3,300 a/a; 20% disaggregate sand grains; trace pyrite clumps

3,300-3,330 a/a; 20% disaggregate sand grains; local lamination of mudstone

3,330-3,360 a/a; 30% white, crumbly, possibly tuffaceous; trace pyrite-coated fracture surfaces; mudstone occasionally laminated

3,360-3,390 80% pebbly tuffaceous SANDSTONE, poorly sorted, with slightly altered white calcareous clay matrix; clasts predominately silicified cryptocrystalline material (chlorite or rhyolite) angular to subrounded, with lesser angular quartz and feldspar; matrix bleached, crumbly with common disseminated pyrite; some pyrite-coated surfaces;
20% light brown MUDSTONE, a/a

3,390-3,420 60% CLAYSTONE, predominately light green-gray, grades to light brown, well consolidated, very slight calcite; locally grades to mudstone
40% tuffaceous SANDSTONE a/a, grades to crystal-rich lithic tuff; locally with sparry calcareous cement; locally silicified

3,420-3,450 70% TUFF or tuffaceous sediment, white, predominately aphanitic, locally fine-grained, includes some mottled and banded textures; highly silicified in part
30% CLAYSTONE, a/a

3,450-3,480 CLAYSTONE & MUDSTONE, predominately light green-gray, locally sandy, well consolidated, slightly calcareous; trace tuff a/a; trace slickensides; trace drusy quartz; trace opalitic alternation of claystone.

3,480-3,510 a/a; minor poorly sorted SANDSTONE

3,510-3,540 a/a; no drusy quartz or opalitic alteration; some claystone has thin randomly oriented stringers and blebs of black shiny material; minor disaggregate sand grains

3,540-3,570	60% CLAYSTONE & MUDSTONE, predominately light green-gray grades to light brown, locally sandy, well consolidated, slightly calcareous; trace slickensides 30% SANDSTONE & SILTSTONE, possibly tuffaceous with white clay-rich matrix, locally silicified; trace drusy silica-coated fracture surfaces 10% disaggregate granitic and metasediment sand grains
3,570-3,600	70% MUDSTONE & CLAYSTONE, predominately light green-gray, well consolidated, slightly calcareous; trace slickensides; trace pyrite clumps 20% SILTSTONE & minor SANDSTONE, clay-rich, tuffaceous in part, with widespread white clay matrix; trace disseminated pyrite 10% disaggregate granitic and metasediment sand clasts with abundant dark weathering stain
3,600-3,630	MUDSTONE, predominately light green-gray grades to light brown, well consolidated, slightly calcareous, variegated texture; locally bleached, locally with very fine disseminated sulfide(?) mineral; possibly tuffaceous in part.
3,630-3,660	a/a; grades locally to tuffaceous sandstone; locally contains fine platy black material (mica flakes?); possibly includes some fine-grained tuffs
3,660-3,690	a/a; contains some angular quartz, feldspar and hornblende grains; trace pyrite clumps; minor incipient white clay alteration; probably tuffaceous sediments with possibly devitrified tuffs
3,690-3,720	a/a; contains abundant angular crystals of calcite in clay maxtrix with disseminated pyrite; minor tuffaceous SANDSTONE & SILTSTONE
3,720-3,750	a/a; more variable, increase tuffaceous(?) sediments, very calcareous
3,750-3,780	MUDSTONE, SILTSTONE, minor SANDSTONE, light green gray to light gray to nearly white, calcareous, locally laminated, with disseminated pyrite and calcareous crystals; possibly tuffaceous in part
3,780-3,810	a/a; 30% light brown laminated tuffaceous MUDSTONE & SILTSTONE, other greenish and brownish variety contains embedded euhedral calcareous rhombohedra; trace pyrite clumps, possibly marcasite
3,810-3,840	a/a; abundant disseminated calcite euhedra up to several mm diameter
3,840-3,870	a/a; abundant coarse calcareous fragments (5% of sample)

3,870-3,900	CLAYSTONE & MUDSTONE, light green-gray grades to minor light brown, well consolidated, slightly calcareous; grades to minor siltstone and fine sandstone; fine disseminated pyrite and calcareous crystals; calcareous euhedral best developed in brown siltstone (rhombs); 1% disaggregated subrounded sand clasts and minor tan-colored sandstone and siltstone (slough?)
3,900-3,930	a/a; possibly tuffaceous in part; 1% disaggregate sand clasts; 1% coarse calcareous fragments; trace slickensides
3,930-3,960	a/a; 1% disaggregate sand grains; 2% coarse calcareous fragments; trace slickensides; minor white granular friable mineral aggregates with pyrite-rich bands (zeolite vein?)
3,960-3,990	CLAYSTONE & MUDSTONE, light green-gray grades to minor light brown, well consolidated, slightly calcareous; grades to minor siltstone and sandstone; locally banded with very fine pyrite concentrations; pyrite disseminated in tiny streaks and blebs; euhedral calcareous rhombs (up to 1 mm) disseminated in many grains; ∿3% light colored, silicified, possibly tuffaceous; trace disaggregate sand grains; trace coarse calcareous fragments
3,990-4,020	a/a
4,020-4,050	a/a; increase coarse sand content (∿10%), disseminated in claystone; trace vitreous quartz vein material; trace slickensides; increase siltstone fraction
4,050-4,080	MUDSTONE & SILTSTONE, predominately green-gray, well consolidated, sandy in part (sample contains 20% disaggregate, medium to coarse sand clasts), grades to minor claystone and trace sandstone; pryite in fine, dendritic growths, possibly intergrown with magnetite; 20% light colored fine grain silicified tuff fragments, banded in part with thin silica veinlets; trace drusy quartz coatings on fractured surfaces
4,080-4,110	a/a; trace silicified tuff
4,110-4,140	a/a; trace silicified tuff.
4,140-4,170	MUDSTONE, CLAYSTONE & SILTSTONE, predominately green-gray, well consolidated, with approximately 5% dispersed medium to coarse sand clasts; dendritic pyrite and euhedral calcareous rhombs disseminated in many fragments; pyrite and calcareous crystals occasionally in clumps; trace slickensides
4,170-4,200	a/a, mostly MUDSTONE, more uniform texture, light green-gray to gray-brown color, 1% sand clasts

4,200-4,230	a/a; mostly MUDSTONE & SILTSTONE, light green-gray to light gray-brown, trace sandy clasts; trace angular black basalt fragments
4,230-4,250	a/a; mostly MUDSTONE & SILTSTONE, grades to minor fine grained sandstone; predominately green-gray, grades to gray-brown; trace black carbonaceous variation; minor coarse sand clasts; trace black basalt fragments; trace tuffaceous(?) mudstone; trace slickensides
4,250-4,270	CLAYSTONE, MUDSTONE & SILTSTONE, light green-gray to light brown, well consolidate, locally sandy, grades to minor fine-grained sandstone; trace disseminated calcareous crystals, pyrite; trace tuffaceous(?) siltstone; ∿5% disaggregate coarse sand grains, pyrite clumps, and coarse calcareous fragments; trace basalt fragments, Note: very slow penetration
4,270-4,280	a/a; predominately light brown MUDSTONE & SILTSTONE, locally with abundant disseminated euhedral calcite crystals; trace slickensided fragments and waxy sheared material, Note: continued very slow penetration
4,280-4,290	a/a; 70% light brown MUDSTONE & SILTSTONE; trace slickensides and waxy sheared material
4,290-4,300	SILTSTONE and very fine grained SANDSTONE, light brown to light gray and light green-gray, calcareous, moderately to well consolidated; minor MUDSTONE; 10% disaggregate medium to coarse sand grains; minor disaggregate calcarous fragments and pyrite clumps
4,300-4,310	a/a; 30% very fine-grained SANDSTONE, very calcareous; trace slickensides
4,310-4,320	MUDSTONE & SILTSTONE, minor very fine-grained SANDSTONE, light green-gray to light brown, well consolidated, slightly to very calcareous, locally with abundant disseminated calcite crystals; trace white flaky gouge(?)
4,320-4,330	SILTSTONE and fine-grained SANDSTONE, minor MUDSTONE, light brown, light green-gray, light gray, moderately to well consolidated, poorly sorted, non-calcareous to very calcareous, subrounded clasts; trace disseminated pyrite
4,330-4,340	a/a; locally grades to medium-grain sandstone Note, here and above: many large cuttings, mostly mudstone, well rounded, possibly slough?
4,340-4,350	SANDSTONE & SILTSTONE, light gray, light brown, light green-gray, moderately to poorly sorted, angular to subrounded clasts; greenish to white (altered?) clay cement; tuffaceous in part; minor disseminated pyrite; trace drusy quartz growths on clast surfaces

4,350-4,360	a/a; sample contains 30% light green-gray MUDSTONE & CLAYSTONE, some possibly slough (large, round cuttings); rest mostly tuffaceous sandstone and siltstone.
4,360-4,370	CLAYSTONE, MUDSTONE, SILTSTONE & SANDSTONE in approximately equal parts; light green-gray, light brown, light gray; moderately to poorly sorted, locally with white matrix (especially sandstone); tuffaceous in part; 25% disaggregate coarse sand clasts, subangular to subrounded; minor dissemated pyrite, trace euhedral calcite crystals
4,370-4,380	SANDSTONE and lesser SILTSTONE, predominantly light gray, fine-grained, moderately sorted, moderately lithified, mostly tuffaceous, with white non-calcareous (recrystallized clay?) cement; appears slightly porous; 20% MUDSTONE & CLAYSTONE
4,380-4,390	a/a; decrease mudstone; increase average grain size, grades to medium sandstone, locally gravelly; clasts include much quartz, feldspar, chert, lithified fragments, occasionally much biotite; matrix locally recrystalized to vitreous mineral; some sugary authigenic clay(?) lining of pores; some interstitial quartz
4,390-4,400	a/a; predominantly very fine-grained tuffaceous SANDSTONE; 20% disaggregate coarse sand clasts
4,400-4,430	Tuffaceous SANDSTONE & SILTSTONE, predominantly gray, moderate to well lithified, moderately sorted, locally gravelly; sugary white matrix, occasionally calcite cement; trace pyrite clumps
4,430-4,460	Tuffaceous CONGLOMERATE, SANDSTONE, and minor SILTSTONE and MUDSTONE; light gray, light gray-green, with multicolored silicified cryptocrystalline clasts, moderately to poorly sorted, with light colored clay cement, moderately to well lithified; trace disseminated pyrite; some silica cement
4,460-4,490	a/a; sandstone contains some soft green blebs, apparent selective alteration of certain clasts; pore spaces lined with white material (authigenic clay in part?), locally altered to greenish color; Note: sample contains abundant (40%) large round fragments of mudstone and siltstone--possibly slough(?)
4,490-4,520	a/a; SANDSTONE partly silicified with glassy interstitial quartz; usually with some accompanied green alteration; some calcareous cement; minor yellow-brown Fe stain Note: description ignores 20% mudstone in large round fragments (slough?)
4,520-4,550	a/a; mostly tuffaceous coarse SANDSTONE and CONLOMGERATE, silicified in part

4,550-4,580	a/a; local precipitation of yellow-brown Fe oxides in microfractures; some glassy interstitial quartz in sandstone.
4,580-4,610	a/a; abundant coarse angular fragments of pastel-colored to dark red-brown cryptocrystalline RHYOLITE or CHERT
4,610-4,640	70% SANDSTONE, light gray to light gray-brown, fine- to very fine-grained, locally gravelly, with white clay matrix, locally altered to greenish; possibly tuffaceous in part; yellow-brown Fe stain 30% SILTSTONE, brown to light brown, well sorted, well consolidated, non-calcareous, with coarse-crystalline calcareous veins (distinctive rock)
4,640-4,670	a/a; SANDSTONE more silicified, tuffaceous; increase yellow-brown Fe stain; increase granular fraction, mostly pastel-colored cryptocrystalline silicified rock
4,670-4,700	a/a; siltstone has some planar; sugary fracture surfaces; sandstone coarser-grained, increase yellow-brown Fe stain
4,700-4,730	CONGLOMERATE, SANDSTONE, SILTSTONE; heterogeneous textures, possibly tuffaceous in part; abundant disaggregate multi-colored pebble fragments, predominantly silicified and cryptocrystalline, minor brown SILTSTONE a/a
4,730-4,760	Predominantly CLAYSTONE & MUDSTONE, minor SILTSTONE and SAND-STONE, light green-gray, grades to minor light brown and light gray, well consolidated tuffaceous in part with fine disseminated pyrite and calcite; 10% disaggregate sand clasts
4,760-4,790	80% BASALT/ANDESITE, very dark gray to dark green-gray, partly chloritized and crumbly, feldspar phenocrysts; contains magnetite; trace calcite veins 20% green-gray fine-grained sediments and disaggregate sand clasts (slough)
4,790-4,800	a/a; much of volcanic texture destroyed by alternation; possible chloritized mafic phenocrysts
4,800-4,810	a/a; pyroxene and feldspar phenocrysts; widespread chloritized alternation
4,810-4,820	a/a
4,820-4,830	a/a; increase calcareous veins; 40% slough
4,830-4,840	a/a; trace bright blue-green clay vesicle and fracture filling; 10% slough, Note: fine cuttings (1-2 mm) throughout volcanic section
4,840-4,850	a/a; 10% slough

4,850-4,860	a/a; sparse pyroxene(?) phenocrysts
4,860-4,870	80% BASALT/ANDESITE, very dark gray to green-gray, widespread chloritized alteration with much destruction of volcanic texture; feldspar phenocrysts, possibly sparse chloritized mafic phenocrysts; slight vesicles, cavities lines with greenish material; trace calcareous veins 20% slough from overlying sediments
4,870-4,880	a/a; 10% sediment slough
4,880-4,890	a/a; 10% sediment slough; slight increase calcareous veins
4,890-4,900	a/a; increase chloritized alteration; 10% sediment slough
4,900-4,920	a/a; increase chloritized alteration; 5% sediment slough Note: contained very fine cuttings, ∿1 mm diameter
4,920-4,930	a/a; grades to light gray, silicified with possibly quartz phenocrysts (rhyodacite?); 5% slough
4,930-4,940	95% ANDESITE/DACITE(?), very dark gray to light green-gray, altered (clay, chlorite), crubbly feldspar, phenocrysts, possibly quartz phenocrysts 5% sediment slough
4,940-4,950	a/a; darker average color
4,950-4,960	95% BASALT/ANDESITE, very dark gray, grades to green-gray, altered (chlorite, clay), feldspar phenocrysts; trace calcareous veins 5% sediment slough
4,960-4,980	a/a
4,980-4,990	a/a; heterogeneous textures (includes vesicular variety and sediments) and compact; probably interflow rubble; trace silica veins
4,990-5,000	Heterogeneous volcanic fragments, predominantly dark greenish gray BASALT/ANDESTIE, partly to highly altered, variable texture (compact, vesicular, variable grain size); trace DACITE(?), trace volcanic sediments; trace silica and calcite veins; trace white silicified material with veinlets of glassy quartz; 20% sediment slough, Note: normal-sized cuttings (to 5 mm).
5,000-5,010	a/a; includes some volcanic sediment; increase white silicified material (3%)

5,010-5,030	90% Silicic TUFF, red-brown, grades to gray-brown; contains tiny crystals glassy feldspar, quartz, fragments devitrified pumice, lithic fragments, also chalky white material with quartz veinlets; variable texture, grain size 10% sediment and volcanic slough
5,030-5,040	a/a; TUFF extrusive heterogeneous color (red-brown, light gray, gray-brown) and texture (grain size, crystal and lithic properties, degree of devitrification, etc.); possibly tuffaceous sediment
5,040-5,050	Silicic TUFFS, red-brown, brown, gray, white, greenish; mostly non-welded, some lithic, some crystal-rich, some silicified; extreme variable texture; possibly tuffaceous conglomerate
5,050-5,060	a/a; probably conglomerate with predominantly silicified tuff cobbles and brown sandy matrix
5,060-5,080	a/a
5,080-5,090	a/a; extreme heterogeneous silicic tuff fragments and abundant chert and metasediment fragments
5,090-5,100	a/a; predominantly red-brown and gray crubmly silicic TUFFS
5,100-5,110	Silicic TUFF, red-brown grades to gray-brown and greenish gray, fine-grained, non-welded, crumbly, locally crystal-rich, lithic in part, contains fragments of older tuffs
5,110-5,120	a/a; slight vesicular
5,120-5,130	a/a; sample contain 40% slough
5,130-5,140	a/a; generally finer-grained, grades to tuffaceous siltstone?
5,140-5,150	a/a; increase lithic fragments
5,150-5,160	Heterogeneous silicic tuff fragment, multicolored, extremely variable grain size and texture; abundant lithologic fragments, mostly light-colored, cryptocrystalline, silica; possibly tuffaceous sediment
5,160-5,170	a/a; 30% disaggregate grains of pastel-colored cryptocrystalline silicic fragments
5,170-5,180	60% CLAYSTONE & MUDSTONE, light green-gray, well consolidated, calcareous, common slickensides; 40% Heterogeneous TUFF fragments a/a; also minor very dark gray basalt(?) Note: Claystone and mudstone identical to some sediments up-hole: possibly slough.

5,180-5,190	Heterogeneous silicic TUFF fragments, cryptocrystalline silicic fragments, basalt/andesite fragments, and claystone and siltstone fragments; suspect conglomerate with predominantly pyroclastic cobbles and much interbedded claystone and siltstone or slough from up-hole
5,190-5,200	a/a; heterogeneity suggests volcaniclastic conglomerate, but matrix material not apparent
5,200-5,210	a/a; trace yellow Fe stain
5,210-5,220	a/a; tuffaceous CONGLOMERATE?
5,220-5,230	a/a; 60% greenish gray MUDSTONE & CLAYSTONE, predominantly in round cuttings
5,230-5,240	a/a; 40% CLAYSTONE/MUDSTONE, appears tuffaceous, predominantly in well round cuttings
5,240-5,250	CONGLOMERATE; multicolored, clasts predominantly volcanic rocks (silicified tuffs of many variations and minor andesite(?) fragments) and chert; white non-calcareous clay matrix, moderately consolidated; 25% claystone/mudstone slough(?)
5,250-5,260	a/a; 50% well rounded CLAYSTONE/MUDSTONE
5,260-5,270	60% diverse fragments of silicified TUFF, tuffaceous and volcaniclastic sediments, SANDSTONE & SILTSTONE, CHERT, cherty SANDSTONE & CONGLOMERATE, & CLAYSTONE (small angular cuttings) 40% large round cuttings, light green to light brown and light gray MUDSTONE, CLAYSTONE, & SILTSTONE (slough?)
5,270-5,280	a/a; 10% large round CLAYSTONE/MUDSTONE cuttings; remainder includes some BASALT/ANDESITE fragments Note: Many greenish claystone fragments appear to be tuffaceous in part, contains fine euhedral crystals, feldspar, hornblende, biotite
5,280-5,290	a/a; 40% large round CLAYSTONE/MUDSTONE cuttings
5,290-5,300	60% CLAYSTONE, light green to gray and brownish, moderately consolidated, with very fine disseminated pyrite crystals; small angular cuttings, trace slickensides, trace embedded euhedral calcareous crystals 20% TUFF or tuffaceous sediment, light red-brown, very fine-grain, clay-rich, with tiny crystals of feldspar and biotite 20% diverse fragments of other silicified TUFFS, tuffaceous SILTSTONE, BASALT, CHERT Note: Almost no large round claystone/mudstone cuttings in sample

5,300-5,310	a/a; 60% greenish CLAYSTONE, tuffaceous in part; 30% red-brown silicified TUFF; 10% miscellaneous other fragments
5,310-5,320	60% large round CLAYSTONE/MUDSTONE/SILTSTONE cuttings 20% red-brown silicified TUFF or tuffaceous sediment a/a 20% chert-rich SILTSTONE, SANDSTONE, and CONGLOMERATE with well lithified white non-calcareous cement; includes associated disaggregate chert and metasediment fragments; trace basalt fragments Note: Some of large chert-rich siltstone and sandstone cuttings also rounded by abrasion
5,320-5,330	70% white RHYOLITE with red-brown stain, cryptocrystalline to microcrystalline, hackly uneven fracture, heavy Fe stain 15% large round CLAYSTONE/MUDSTONE cuttings 15% miscellaneous silicified TUFFS; sediments and chert and metasedimentary fragments
5,330-5,340	85% white RHYOLITE, a/a; possibly pearly white sericite pseudomorphs (altered phenocrysts?) 10% red-brown TUFFS and volcanic sediments 5% CLAYSTONE, trace pyrite, trace CHERT
5,340-5,350	50% greenish and brownish MUDSTONE/CLAYSTONE in large mud cuttings 40% white RHYOLITE a/a; pearly white "phenocrysts" appear to be sericitized mica crystals (platy habit, hexagonal outline) 10% red-brown TUFFS and volcanic sediments
5,350-5,360	85% white cryptocrystalline RHYOLITE a/a; red-brown stain may be due in part to oxidation of disseminated pyrite crystals 15% red-brown silicified TUFF and varicolored MUDSTONE/CLAYSTONE
5,360-5,370	90% white RHYOLITE with splotchy red-brown stain, cryptocrystalline to minor microcrystalline, with hackly uneven surfaces; phenocrysts altered almost beyond recognition: mica (biotite?) now pearly sericite pseudomorphs with hexagonal outline and faint platy cleavage; feldspar(?) now pinkish and yellowish clay; some vugs, irregular shape, lined with very fine hematite and yellow vitreous mineral 10% dark red-brown clay-rich TUFF or sediment; possibly associated with white rhyolite, relation not clear; possibly crack filling
5,370-5,380	85% white RHYOLITE a/a; contain some coarse-grained anhedral vitreous quartz grains; dark sugary brown mineral precipitation on vug surfaces, also sugary yellow mineral

15% miscellaneous, mostly dark red-brown, light blue-green, gray, and pinkish clay-rich material; pinkish variation appears to be alteration product of a blocky or prismatic mineral in white rock (K-feldspar?); some of red-brown variation possibly clings to rhyolite fragments; trace white cryptocrystalline silica veins

5,380-5,390 a/a; minor flaky greenish and whitish material with pearly luster, appears alteration of feldspar (incipient sericitization?); contained yellow and brown precipitation in vugs; contained vague outlines of muscovite pseudomorphs
Note: this sample relatively heterogeneous

5,400-5,410 85% white RHYOLITE, predominantly cryptocrystalline, with odd-shaped quartz veins of intergrowths; partly kaolinized and possibly slightly sericitized, trace possible oxidized mafic mineral; abundant dark brown and yellow precipitation lining vugs; trace drusy quartz
15% miscellaneous volcanic and sediment fragments

5,410-5,420 a/a; variable pastel-colored, pinkish, greenish, grayish; much vitreous quartz present, apparent veins
Note: noticeable decrease in red-brown weathering stain and dark red-brown clay-rich material

5,420-5,430 a/a; multicolored pastels; trac white silica veins, trace drusy quartz on surfaces of some fragments; trace bluish alteration with fine disseminated pyrite; altered mica phenocrysts up to 3 mm
Note: complete absence of any mafic minerals

5,430-5,440 a/a; minor soft white kaolinite alteration; locally slightly greenish discoloration; contained minor hematite stain and coatings; contained minor bronze-colored and yellow drusy crystal coatings on vug surface
Note: Texture is indistinct and the relation between quartz and the rest of the rock is unclear; no recognizable mafic minerals are present; the amount of hematite staining has diminished; no distinct chlorite clumps are present, representing former mafic minerals; much of white material still appears to be cryptocrystalline - no distinct feldspar cleavages are visible; some grains suggest in-situ co-existence of leucocratic fragments and soft bluish and dark brown material, but the relation is unclear.

5,440-5,450 80% RHYOLITE, white, cryptocrystalline, partly altered or weathered, locally bluish and grayish colored; trace hematite stain, trace bronze to dark red-brown precipitation on fracture surface and vug surfaces; no visible mafic minerals
20% miscellaneous brown, gray, greenish soft clay-rich fragments, probably tuffs and sediments; trace chert and metasediment fragments

5,450-5,460	a/a; 30% miscellaneous fragments, mostly slough from up-hole
5,460-5,470	a/a; trace sericite pseudomorphs after mica phenocrysts some brown clay-rich fragments also have bronze-colored coating (possibly in situ co-existence?); trace very fine-grained quartzite or aplite, vitreous, with tiny intergrown chlorite(?) crystals; some green/white and brown/white streaky sheared material and trace waxy green material (gouge?)
5,470-5,480	a/a, more heterogeneous; much quartz-rich material appears granular (like quartzite); some obvious quartz veining locally; more variable color, pinkish, blueish, grayish, reddish; contained bronze- or copper-red vug lining; possibly volcanic sediment?
5,480-5,490	Same as 5,470-5,480: variable textures and colors; Note: 25% obvious slough from up-hole
5,490-5,500	Same as 5,470-5,480; even wider variation in color, includes some grains with splotchy dark-green chlorite; possibly volcanic conglomerate?; contained much slough
5,500-5,510	METACONGLOMERATE(?), white and partel colors, occasionally dark green, clasts of white to grayish quartzite, chloritized mafic igneous rock, silicified before metamorphism; contained trace copper-red surface coatings
5,510-5,520	a/a; less texture and color variation; much cryptocrystalline rock, white, greenish, grayish, and pinkish; very little quartz; trace pyrite intergrowths with quartz, some grains very dark green with chlorite
5,520-5,530	a/a; less color variation, more vitreous quartz; contained minor chlorite-rich fragments; trace sericitized(?) mica crystals; trace pyrite intergrowths with quartz and chlorite; minor quartzite; trace slickensides Note: this sample appears closer to rhyolite
5,530-5,540	a/a; less color variation; much granular quartz; much hackly white cryptocrystalline material with occasional pearly white muscovite pseudomorphs; chlorite coatings on planar surface, occasionally with slickensides, associated with calcite.
5,540-5,550	RHYOLITE (tuff?), mostly white, partly with greenish or gray tint; some grains green (contain chlorite), possibly lithologic inclusions; most milky, cryptocrystalline, some vitreous quartz grains; some sericitized mica flakes; trace pyrite
5,550-5,560	a/a; trace microgranular quartz with tiny interstitial green mineral; trace waxy shear surfaces

5,560-5,570	a/a; extreme leucocratic, no mafic minerals; contained sericite pseudomorphs after mica
5,570-5,580	a/a; extremely leucocratic, no mafic minerals
5,580-5,590	a/a; extremely leucocratic; trace drusy quartz; no visible mica pseudomorphs
5,590-5,600	a/a; no visible mica pseudomorphs
5,600-5,610	a/a; no visible mica pseudomorphs
5,610-5,620	a/a; no visible mafic minerals; trace mica pseudomorphs; trace white cryptocrystalline silica veins; trace chlorite/ calcite grains
5,620-5,630	a/a; fragments more diverse color (white, grayish, greenish), some chlorite-rich; some fragments have waxy, sheared look; probably lithic tuff Note: contained trace copper-red precipitation on some surfaces
5,630-5,640	a/a; contained diverse color and texture; probably lithic tuff
5,640-5,650	a/a; great diversity in color, texture appears volcanic sediment or lithic tuff
5,650-5,660	a/a; contained great diversity in color, texture; some copper-red precipitation in vugs; contained occasional sericite pseudomorphs after mica; trace waxy, slickensided shear surfaces
5,660-5,670	a/a
5,670-5,680	a/a; trace coarse calcareous fragments; contained trace pyrite, unevenly disseminated
5,680-5,690	RHYOLITE, white grades to grayish and greenish, cryptocrystalline to microcrystalline, variable texture locally banded; occasionally pearly sericite pseudomorphs of mica phenocrysts; trace pyrite in clumps and in streaks; trace dark green waxy fragments with slickensides; trace very fine black needles (tourmaline?); some microgranulars, crumbly white material
5,690-5,700	a/a; very abundant (50%) alteration to light brownish greasy material (incipient sericitization?); contained diverse textures and colors; contained trace microgranular white material
5,700-5,710	a/a; much sericitic(?) alteration; trace coarse quartz fragments

5,710-5,720	60% white cryptocrystalline RHYOLITE a/a with much sericitic(?) alteration 40% fine-grained GRANITE with greenish and brownish mica, slightly kaolinized
5,720-5,730	80% GRANITE, white, with quartz, feldspar (partly kaolinized) and minor light greenish gray and brownish mica; common disseminated pyrite; trace waxy sheared material 20% white to grayish cryptocrystalline RHYOLITE a/a, partly altered
5,730-5,740	a/a; 95% GRANITE; mica is biotite, possibly altering to muscovite Note: rapid drilling since ∿5,720
5,740-5,750	GRANITE, white, fine-grained, with quartz, feldspar, mica
5,750-5,760	a/a
5,760-5,770	a/a; trace gray-brown waxy sheared material; micas are green-gray and copper-brown (muscovite and biotite?) trace kaolinite with interspersed mica; no sericite, no pyrite
5,770-5,780	a/a; mica predominantly brown; trace gray-brown waxy sheared material; trace sericite; no pyrite
5,780-5,790	a/a; mica predominantly brown; trace gray-brown waxy sheared material; trace sericite, no pyrite
5,790-5,800	a/a; mica predominantly brown; trace black biotite; trace waxy sheared material; trace sericite, no pyrite
5,800-5,810	a/a; mica predominantly brown; trace waxy sheared material; trace sericite; trace pyrite
5,810-5,820	a/a; trace sericite; trace waxy sheared material; micas greenish and brown as before, common cryptocrystalline greenish, brownish and white rhyolite fragments; no pyrite Note: this sample has a slightly different appearance, possibly brecciated in part
5,820-5,830	a/a; trace waxy sheared material; trace sericite; trace pyrite
5,830-5,840	GRANITE, white, fine-grained, with quartz, feldspar (partly kaolinized), and greenish and brownish mica; common hard whitish cryptocrystalline rhyolite with greenish splotches, trace waxy shear surfaces; possibly microbrecciated textures Note: this sample looks more quartz-rich and more competent than above; larger cuttings size

5,840-5,850	40% GRANITE a/a; remainder very heterogeneous fragments including abundant white cryptocrystalline rhyolite and abundant pale brown microcrystalline altered material with pearly luster, common fine-grained polycrystalline quartz fragments
5,850-5,860	80% very heterogeneous fragments, including greenish volcanic and metavolcanic rocks, very fine-grained quartz aggregate (possibly vein material), white cryptocrystalline rhyolite, white kaolinite, pearly sericite 20% GRANITE a/a Note: very heterogeneous sample; possibly contact zone
5,860-5,870	50% volcanic and metavolcanic fragments in variable stages of alteration from nearly fresh basalt to biotite amphibolite 40% GRANITE a/a 10% light colored quartz-rich microgranular rock, locally with much intergrown mica (greisen?) 10% cryptocrystalline white RHYOLITE, partly altered to greasy brownish material Note: very heterogeneous cuttings
5,870-5,880	50% variably altered and recrystalized mafic volcanic rock a/a; slightly more modified; includes greenish felty rock and brownish and greenish black biotite with hornblende 30% miscellaneous, includes polycrystalline quartz (veins?), white cryptocrystalline rhyolite (slough?), brownish mylonite(?) 20% GRANITE a/a Note: some fragments have slightly polished surfaces
5,880-5,890	50% mesocratic and melanocratic fragments, mostly biotite-rich, locally chloritized, with intergrown quartz, feldspar, calcite, pyrite; possibly quartz veins; trace waxy sheared material; trace fragments with relict volcanic texture 30% GRANITE a/a and white rhyolite 20% heterogeneous leucocratic fragments with highly variable texture and grain size, cryptocrystalline to fine-grained; contains quartz, feldspar, zeolite(?), locally with abundant brownish and greenish mica; streaky in part, locally kaolinized
5,890-5,900	a/a; trace drusy quartz on fracture surfaces; trac epidote in melanocratic fragments, disseminated and in veinlets; slightly more leucocratic; trace calcareous veins
5,900-5,910	a/a; trace epidote associated with melanocratic rock; trace metavolcanic fragments; extremely variable textures and composition

5,910-5,920	a/a; increase in extremely fine-grained leucocratic (quartz and zeolite?) fragments with variable texture and variable mineral proportions; contained trace epidote; some waxy sheared material; trace drusy quartz on fracture surfaces
5,920-5,930	a/a; contained increase leucocratic fraction, includes granite and rhyolite; trace drusy quartz on fracture surfaces; variable biotite content in quartz-rich fragments; very heterogeneous textures
5,930-5,940	70% leucocratic metamorphic(?) fragments, predominantly very fine grained with erractic texture; contains quartz, feldspar, and minor mica (green and brown); trace interstitial magnetite; includes minor kaolinized fragments; trace drusy quartz clusters; possibly zeolite alteration of feldspar 20% cryptocrystalline rhyolite and granite fragments 10% mesocratic and melanocratic fragments, predominantly biotite-rich, locally chloritic; trace light green low-grade metavolcanic; trace waxy green sheared material; trace pyrite Note: many fragments are nearly pure polycrystalline quartz with green and brown biotite/chlorite dusting
5,940-5,950	a/a; 95% leucocratic fragments with very little intergrown mica; trace pyrite; trace metavolcanic fragments; trace drusy quartz fracture coatings; trace dark green waxy sheared material; contained very fine-grained texture; some quartz in large crystals (veins?)
5,950-5,960	a/a; increase drusy quartz; contained minor kaolinized fragments with common streaky appearance
5,960-5,970	a/a; contained predominantly very fine-grained texture; common drusy quartz; contained very leucocratic character
5,970-5,980	a/a; no visible drusy quartz; contained trace intergrown magnetite.
5,980-5,990	a/a; slightly increased kaolinized fragments with streaks of chlorite
5,990-6,000	a/a; contained trace intergrown magnetite; contained very heterogeneous texture and mineral make-up
6,000-6,010	a/a; slightly darker average color Note: last several samples have had no visible drusy quartz
6,010-6,020	a/a; slightly darker color, but this sample very silicified; many grains nearly pure fine- to very fine-grained polycrystalline quartz with variable, irregular texture; trace epidote associated with biotite; trace disseminated pyrite

6,020-6,030	a/a; darker color (overall increase biotite/chlorite), contained microgranular texture; trace green-black amphibolite fragments, trace light green metavolcanic fragments; widespread kaolinization, most grains affected somewhat; trace disseminated pyrite
6,030-6,040	a/a; slightly darker color; trace biotite-amphibolite with epidote; contained wide grain-size variation; widespread kaolinization, trace disseminated pyrite; widespread chlorite, especially in kaolinized fragments; trace calcareous veins
6,040-6,050	80% heterogeneous leucocratic fragments, quartz-rich, predominantly extremely fine-grained, contains quartz, feldspar (partly to completely kaolinized) biotite and chlorite (after biotite?) with trace magnetite and disseminated pyrite; include ∿25% fragments with only kaolinite and chlorite, mostly with streaky sheared appearance, also trace sericite, minor large feldspar, quartz, and calcareous fragments; trace white cryptocrystalline rhyolite 20% mesocratic and melanocratic fragments, rich in biotite and chlorite with trace epidote and calcite, variably intergrown with quartz and feldspar
6,050-6,060	a/a
6,060-6,070	a/a; decrease kaolinization; decrease chloritzation
6,070-6,080	a/a; increase white cryptocrystalline banded (and/or veined) rhyolite fragments and coarse feldspar/quartz fragments (together 20%); minor kaolinization; trace drusy quartz
6,080-6,090	a/a; sample includes 30% white to greenish and grayish cryptocrystalline RHYOLITE(?) and minor GRANITE with brown mica; minor kaolinization
6,090-6,100	a/a; sample includes 10% white to greenish and grayish cryptocrystalline RHYOLITE(?); contained predominantly very fine-grain texture; widespread but less intense kaolinization; Note: no drusy quartz noted since 6,080 feet
6,100-6,110	a/a; sample includes 10% white to greenish and grayish cryptocrystalline RHYOLITE (with trace sericite pseudomorphs of mica phenocrysts), slightly altered in part (incipient sericite?); minor quartz-feldspar-mica GRANITE; trace volcanic (andesite?) fragments; trace drusy quartz; trace tourmaline intergrown with coarse quartz and feldspar; minor kaolinization

6,110-6,120	a/a; more melanocratic, less kaolinized (larger cuttings); includes 5% cryptocrystalline rhyolite fragments, 5% recognizable volcanic and metavolcanic fragments; trace GRANITE; contained trace disseminated pyrite; Note: very competent rock; samples have become progressively more melanocratic
6,120-6,130	a/a; more melanocratic (60% leucocratic fragments); minor cryptocrystalline rhyolite fragments; minor metavolcanic fragments; minor kaolinization; contained very fine-grained but highly variable texture; quartz in large crystals in part
6,130-6,140	a/a; minor cryptocrystalline rhyolite fragments; trace metavolcanic fragments; trace drusy quartz crystals; trace epidote in melanocratic fragments; widespread chloritization of biotite, zeolitization and kaolinization of feldspar; quartz possibly in veins
6,140-6,150	90% leucocratic metamorphic fragments, predominantly very fine-grained but variable; feldspar-rich with abundant quartz (introduced?) and biotite/chlorite; feldspar vitreous to milky, possibly zeolitized in part, kaolinized in part; trace magnetite; trace black tourmaline intergrown with coarser quartz and feldspar; trace drusy quartz 10% mesocratic and melanocratic fragments, mostly biotite and chlorite-rich, usually with intergorwn quartz and feldspar; trace epidote; includes minor andesite fragments; trace disseminated pyrite
6,150-6,160	a/a; increase kaolinization; trace drusy quartz; trace epidote in melanocratic fragments; trace graniite fragments; Note, here and above; quartz primarily in large crystals, possibly veins in fine-grained rock
6,160-6,170	a/a; very leucocratic; includes 10% white to grayish cryptocrystalline rhyolite, partly altered (sericitized?) contained highly variable texture
6,170-6,180	a/a; widespread zeolitization(?) and chloritization; minor kaolinization; predominantly sugary white feldspar (or zeolite?) with streaks and blebs of chlorite; trace cryptocrystalline rhyolite; sample very leucocratic
6,180-6,190	a/a; minor kaolinization; contained trace interstitial magnetite; trace intergrown tourmaline; 10% white cryptocrystalline rhyolite fragments
6,190-6,200	a/a; 5% cryptocrystalline rhyolite fragments, slightly sericitized in part; trace kaolinization; contained disseminated pyrite

6,200-6,210	a/a; 20% white to grayish cryptocrystalline rhyolite fragments with quartz and feldspar phenocrysts and round inclusions of very fine-grained quartzite; trace kaolinization; trace drusy quartz; trace tourmaline prisms; common disseminated pyrite
6,210-6,220	a/a; minor white to grayish cryptocrystalline RHYOLITE, partly sericitized; trace kaolinization; Note: this sample predominantly extremely fine-grained
6,220-6,230	a/a; 10% white to grayish cryptocrystalline RHYOLITE, occasionally mottled, with quartz phenocrysts; trace drusy quartz on fractured surfaces; contained trace fine-grained GRANITE with brown mica; trace green waxy sheared material; no kaolinization
6,230-6,240	a/a; 10% white to grayish cryptocrystalline RHYOLITE, slightly sericitized in part; trace drusy quartz; trace kaolinization; much coarse-grained quartz
6,240-6,250	a/a; minor cryptocrystalline RHYOLITE; Note: this rock is mostly extremely fine-grained, and mafic minerals tend to be more concentrated in clots
6,240-6,250	Contact metamorphic rock, white to green, predominantly extremely fine-grained, but variable to fine-grained; contains quartz, feldspar (albite?), chlorite, trace pyrite; texture erratic, mostly sugary and massive, locally schistose or foliated; mineral proportions also variable, with mafic minerals concentrated in streaks and splotches; trace granite fragments; trace cryptocrystalline rhyolite fragments; Note: change in description format does not imply sudden change in rock character
6,250-6,260	a/a; 5% cryptocrystalline rhyolite fragments, slightly sericitized in part
6,260-6,270	a/a; trace epidote in mafic fragments
6,270-6,280	a/a; coarser average grain size; increase quartz content (mostly coarse-grained)
6,280-6,290	a/a; trace metavolcanic fragments
6,290-6,300	a/a; trace drusy quartz on fractured surfaces
6,300-6,310	a/a; minor cryptocrystalline rhyolite fragments; minor kaolinization
6,310-6,320	a/a; extremely variable texture and mineral proportions

6,320-6,330	Contact metamorphic rock, white, gray, greenish, predominantly extremely fine-grained; contains feldspar (and/or zeolite?), biotite, chlorite, muscovite, quartz (mostly coarser-grain, possibly vein mineral), trace disseminated pyrite, trace interstitial magnetite; texture and grain size variable, predominantely granular with biotite/chlorite-rich streaks and splotches, occasionally schistose or foliated; trace granite and rhyolite fragments; trace drusy quartz
6,330-6,340	a/a; minor kaolinization
6,340-6,350	a/a; biotite/chlorite more evenly distributed; minor kaolinization
6,350-6,360	a/a; more mafic, some fragments nearly black, contains hornblende (often in much larger crystals than average grain size of rock); contained trace granite and cryptocrystalline rhyolite fragments
6,360-6,370	a/a; common light brown greasy cryptocrystalline, altered RHYOLITE; trace kaolinization; abundant coarse-grain quartz; trace slickensides
6,370-6,380	a/a; very leucocratic; virtually no kaolinization, pervasive microbrecciated appearance
6,380-6,390	a/a; very leucocratic; contained erratic texture; 5% cryptocrystalline RHYOLITE
6,390-6,400	a/a; very leucocratic, 10% kaolinized; extremely fine-grained; contained erratic texture; Note: very fine cuttings (1-2 mm)
6,400-6,410	a/a; very leucocratic; 15% kaolinized; 15% cryptocrystalline rhyolite fragments; trace coase muscovite flakes; Note: very fine cuttings (1-2 mm)
6,410-6,420	a/a; very leucocratic; 10% kaolinized; trace intergrown tourmaline; trace coarse muscovite flakes; contained erratic texture and mineral distribution
6,420-6,430	Contact metamorphic rock, white, gray, greenish, extremely fine-grained but variable texture, microgranulated appearance; contain quartz (mostly larger vitreous grains), feldspar (mostly altered), chlorite and biotite; trace disseminated pyrite; trace interstitial magnetite; trace drusy quartz; ~25% of grains intensely kaolinized Note: very leucocratic sample, relatively even-textured
6,430-6,440	a/a; 20% cryptocrystalline rhyolite fragments; 10% kaolinized fragments; minor light brown greasy altered rhyolite

6,440-6,450	a/a; more mafic, more variable; includes many fragments nearly pure biotite or biotite/chlorite; minor cryptocrystalline rhyolite fragments; trace coarse cleavage plates of orthorhombic carbonate; minor kaolinization
6,450-6,460	a/a; slightly more mafic, more variable; minor kaolinization; Note: extremely fine cuttings
6,460-6,470	a/a; more mafic and more variable; contained extremely fine-grained texture; ∿10% kaolinized; Note: extremely fine cuttings
6,470-6,480	a/a; more mafic; ∿30% kaolinized; trace orthorhombic cabonaceous cleavage plates; Note: extremely fine cuttings (∿1 mm)
6,480-6,490	a/a; ∿40% kaolinized
6,490-6,500	a/a; slightly more mafic; ∿5% kaolinized fragments; trace drusy quartz
6,500-6,510	a/a; slightly more mafic, minor kaolinized fragments; contained extremely fine-grained microgranulated appearance
6,510-6,520	a/a; 5% kaolinized fragments; 5% cryptocrystalline rhyolite fragments, partly with greasy sericitized(?) appearance
6,520-6,530	a/a; slightly more mafic; 20% kaolinized fragments; trace colorless clear aragonite cleavage fragments, 20% cryptocrystalline rhyolite fragments
6,530-6,540	Contact metamorphic rock, white, greenish, gray, predominantly extremely fine-grained; contain feldspar (mostly altered to kaolinite, muscovite and zeolite(?), quartz (often in relatively large grains), chlorite (after biotite?), trace disseminated pyrite, trace interstitial magnetite, trace epidote in mafic fragments; texture and grain size variable and irregular; chlorite commonly concentrated in streaks, quartz common in veinlets and large intergrown crystals; 60% of fragments kaolinized; 15% cryptocrystalline RHYOLITE fragments, commonly altered to light brown greasy minerals, and GRANITE; trace aragonite cleavage plates
6,540-6,550	a/a; 30% kaolinized fragments; contained trace aragonite cleavage plates
6,550-6,560	a/a; slightly less mafic; 10% kaolinized fragments; contained trace cryptocrystalline rhyolite and granite
6,560-6,570	a/a; 30% kaolinized grains
6,570-6,580	a/a; 40% kaolinized grains; 20% cryptocrystalline rhyolite fragments and granite; Note: dramatic increase in cuttings size

6,580-6,590	a/a; 60% kaolinized fragments; 15% rhyolite and granite fragments; Note: very incompetent rock dispite slow drill rate
6,590-6,600	a/a; 30% kaolinized fragments; minor rhyolite and granite fragments
6,600-6,610	a/a; 10% kaolinized fragments; minor rhyolite and granite fragments
6,610-6,620	a/a; 5% highly kaolinized fragments; 30% cryptocrystalline RHYOLITE, partly altered to light brown greasy mineraly, and minor granite fragments; Note: coarser cuttings (3-4 mm); more competent rock
6,620-6,630	a/a; trace kaolinization; coarser-grained, more quartz-rich, more competent; trace calcareous coatings on fractured surfaces; 10% rhyolite and granite fragments; Note: contained large cuttings (to 5 mm)
6,630-6,640	a/a; 10% kaolinized fragments, contained erratic texture
6,640-6,650	a/a; 5% kaolinized fragments; minor rhyolite and granite fragments
6,650-6,660	Contact metamorphic rock, white and green-gray, predominantly very fine-grained; contains feldspar, quartz (mostly large grains), biotite, chlorite (after biotite?), trace disseminated pyrite, trace interstitial magnetite, rare epidote; texture and grain size variable and irregular, commonly streaky with chlorite concentrations; no relict texture; quartz possibly in veinlets in part; 20% highly kaolinized grains
6,660-6,670	a/a; minor kaolinization
6,670-6,680	a/a; 20% kaolinized fragments
6,680-6,690	a/a; minor kaolinization; trace muscovite intergrown with feldspar mosaics; trace large disaggregate muscovite flakes
6,690-6,700	a/a; trace large muscovite flakes; 40% kaolinized fragments
6,700-6,710	a/a; trace large muscovite flakes; associated with white feldspar; 10% kaolinized fragments; Note: this sample has relatively large biotite:chlorite ratio
6,710-6,720	a/a; 20% kaolinized fragments; trace drusy quartz
6,720-6,730	a/a; 30% kaolinized fragments; trace disaggregated muscovite flakes; trace schistose texture
6,730-6,740	a/a; minor kaolinization; trace slender tourmaline prisms; contained trace rhyolite and granite fragments

6,740-6,750	a/a; 10% kaolinized fragments; trace drusy quartz; trace slender black prismatic tourmaline
6,750-6,760	a/a; 10% kaolinized fragments; contained trace slender black tourmaline prisms, associated with fine-grained feldspar
6,760-6,770	a/a; 10% kaolinized fragments; common black tourmaline needles, sometimes in radiating clusters; trace drusy quartz
6,770-6,780	a/a; minor kaolinization; trace black tourmaline prisms, occasionally concentrated in streaks; occasionally schistose texture
6,780-6,790	Contact metamorphic rock, predominantly green-gray, very fine-grained, contained feldspar (partly altered to muscovite, kaolinite, possibly zeolite), quartz (not abundant, mostly in large grains), chlorite (evenly distributed in some fragments, splotchy or streaky in others), muscovite; common disseminated pyrite, almost no detectable magnetite; texture variable, but less so than before, no relict texture; ∿60% of fragments highly kaolinized
6,790-6,800	a/a; slightly more variable texture and mineral properties; increase quartz content; trace black tourmaline prisms; Note: sample contains 15% milky white vein quartz
6,800-6,810	a/a; very kaolinized sample; Note: much slough due to bit trip at 6,809 feet
6,810-6,820	a/a; some fragments contain trace biotite; 70% highly kaolinized fragments
6,820-6,830	a/a; highly variable texture; trace tourmaline crystals; 70% highly kaolinized fragments
6,830-6,840	a/a; darker-color, more evenly textured (extremely fine-grained), less streaky; trace tourmaline crystals; trace calcite in fractures; relatively large cuttings; Note: some of darker fragments here could be metabasalt, but no recognizable volcanic texture remains
6,840-6,850	a/a; darker-color, more even-textured; common tourmaline crystals (intergrown with rock fabric); contains trace biotite; brownish epidote(?); minor milky vein quartz; possibly metabasalt
6,850-6,860	a/a; common tourmaline crystals, resume highly variable texture; 30% kaolinized fragments
6,860-6,870	a/a; more even - textured; abundant black tourmaline crystals, common in clusters; 70% highly kaolinized fragments; contained minor vein quartz

6,870-6,880	a/a; abundant black tourmaline crystals, common in clusters, associated with vein quartz as well as intergrown with rock fabric; some mafic fragments contain abundant epidote; ∿40% highly kaolinized fragments
6,880-6,890	a/a; common black tourmaline crystals; contained variable texture; 70% highly kaolinized fragments
6,890-6,900	a/a; common tourmaline crystals; 80% highly kaolinized fragments; trace relict volcanic texture; trace biotite, epidote, and possibly hornblende in mafic fragments
6,900-6,910	a/a; trace tourmaline; trace biotite and hornblende in mafic fragments; 30% highly kaolinized fragments
6,910-6,920	a/a; generally more mafic, with unusually abundant biotite-rich fragments and diverse irregular textures, some possibly MYLONITE or MICROBRECCIA
6,920-6,930	a/a; very heterogeneous textures, includes some with abundant coarse brownish mica in cryptocrystalline white matrix (some fine-grained equivalent as well); some streaky sheared material; trace slickensided surfaces; common brownish white streaky kaolinite with slickensides; Note: driller reports drill strong bouncing in this interval
6,930-6,940	a/a; contained heterogeneous textures, some very irregular, possibly cataclastic; trace polished shear surfaces; abundant coarse mica, partly chloritized; trace soft bluish and green alteration material with slickensides; widespread kaolinization; trace epidote
6,940-6,950	same as 6,930-6,940; slightly more uniform
6,950-6,960	Contact metamorphic rock, green-gray, extremely fine-grained, contains feldspar (mostly kaolinized), quartz (minor, except in veins), biotite (mostly tiny grains, largely chloritized) common disseminated pyrite, trace epidote, trace tourmaline (especially associated with vein quartz); texture variable, streaky in part; widespread kaolinization; ∿3% vein quartz with intergrown tourmaline, coarse greenish chlorite, pyrite, possibly feldspar
6,960-6,970	a/a; trace relict volcanic texture; more uniform texture, but contained variable mineral proportions; vein quartz contained some intergrown muscovite; Note: large cuttings (to 0.5 mm)
6,970-6,980	a/a; extensive kaolinization of feldspar and chloritization of biotite

6,980-6,990	a/a; extensive kaolinization of feldspar and chloritization of biotite; quartz contained mostly in veins; trace drusy quartz on fractured surfaces, contained trace fine-grained muscovite associated with vein quartz
6,990-7,000	a/a; extensive kaolinzation and chloritization; contained highly variable texture and mineral proportions; 3% vein quartz (and feldspar?) with intergrown tourmaline, pyrite
7,000-7,010	a/a; extensive kaolinization and chloritization; minor extremely fine-grained pale brownish quartz-feldspar(?) vein material; trace epidote
7,010-7,020	a/a; more leucocratic; 40% fragments nearly pure quartz and feldspar, variably textured, locally kaolinized
7,020-7,030	Contact metamorphic rock, greenish gray to white, very fine-grained highly variable texture, contains variable proportions of quartz, feldspar, biotite, chlorite, muscovite, epidote, pyrite, kaolinite; generally very leucocratic; some mafic grains have slickensides
7,030-7,040	a/a; some grains with coarse biotite; contained variable texture, generally very leucocratic, moderately kaolinized; trace recognizable volcanic fragments
7,040-7,050	a/a; contained highly variable textures and mineral proportions; extensive kaolinization
7,050-7,060	a/a; contained highly variable textures and mineral proportions; moderate kaolinization; contained common disseminated pyrite; trace drusy quartz and calcite on fractured surfaces
7,060-7,070	a/a; trace tourmaline needles; moderate kaolinization
7,070-7,080	a/a; increase mafic minerals; trace calcareous veinlets; trace drusy quartz on fractured surfaces; minor kaolinization
7,080-7,090	a/a; very wide texture variation, includes some cataclastic(?) textures; trace sheared chlorite-muscovite fragments; contained trace yellow epidote (feldspar alteration?); minor kaolinization
7,090-7,100	a/a; trace blue-gray cryptocrystalline silica; very wide texture and composition variation; abundant quartz in veins; common epidote; trace calcite surface coatings, some coarse quartz-feldspar-biotite-muscovite fragments (granite dikes?)
7,100-7,110	a/a; contained very wide textures and composition variations; common blue-gray to white cryptocrystalline silica (in veins); trace kaolinization

7,110-7,120	a/a; wide composition variation, more uniform very fine-grained texture; common bluish cryptocrystalline silica; common white, brownish mottled kaolinized fragments (gouge?); trace granular fragments (dikes?)
7,120-7,130	a/a; very wide texture and composition variation; trace bluish cryptocrystalline silica; minor kaolinization
7,130-7,140	a/a; very wide texture and composition variation; trace bluish cryptocrystalline silica; minor granite fragments, minor kaolinization
7,140-7,150	a/a; trace bluish cryptocrystalline silica; trace coarse muscovite flakes and aragonite cleavage plates; minor granite fragments; minor kaolinization; some light-colored fragments with pearly sheen; trace muscovite-chlorite SCHIST
7,150-7,160	Contact metamorphic rock, gray green, very fine-grained, with relatively even texture; contains feldspar (partly kaolinized), chlorite, pyrite, calcite; minor quartz veins; trace calcareous veins; trace drusy quartz on fractured surfaces; Note: abrupt change from highly variable samples of last 100 feet or so
7,160-7,170	a/a; highly variable extremely fine-grained textures, streaky in part; trace waxy green material with slickensides; widespread kaolinization
7,170-7,180	BASALT, dark gray (fresh) grades to nearly white (altered), aphanitic texture with sparse plagioclase phenocrysts (fresh) grades to streaky kaolinite-chlorite fragments (altered); many fragments have sheared or cataclastic appearance
7,180-7,190	a/a; more heterogeneous; 30% fresh dark gray basalt, remainder mostly zeolite(?)-chlorite-pyrite rock with highly variable texture; locally kaolinized; common quartz veins; trace tourmaline; trace slickensided surfaces
7,190-7,200	a/a;completely altered and veined; extremely heterogeneous textures and mineral proportions
7,200-7,210	Altered BASALT, light to dark green-gray, very fine-grained with highly variable texture; contains predominantly very fine-grained chlorite and zeolite (muscovite?) with lesser quartz (veins and blebs) and feldspar(?); minor pyrite, epidote and tourmaline; trace cryptocrystalline silica; trace calcite coating on fractured surfaces; trace fresh BASALT
7,210-7,220	a/a; extremely diverse cuttings, grades to some nearly fresh basalt; locally intense kaolinization; Note: much slough from Tertiary section

7,220-7,230	a/a; 20% with recognizable volcanic texture; contained highly variable textures; contained trace tourmaline; minor kaolinization
7,230-7,240	Altered BASALT, dark gray to gray-green and white; 30% with recognizable volcanic texture, microcrystalline, sparse plagioclase phenocrysts; alteration produces light-colored granular to crumbly material with variable proportions of quartz, chlorite, muscovite, zeolite(?), kaolinite, pyrite, epidote; trace calcareous veins, common quartz veins
7,240-7,250	a/a; 90% recognizable volcanic fragments; minor white cryptocrystalline fragments, partly silicified; trace tourmaline; trace tiny reddish patches in slightly altered rock
7,250-7,260	a/a; 70% recognizable volcanic fragments; 20% white cryptocrystalline to microcrystalline rock with tiny silica streaks and blebs commonly arranged in banded pattern; possibly tuff; trace drusy quartz coatings on fractured surfaces
7,260-7,270	a/a; 20% recognizable volcanic fragments; 30% white cryptocrystalline material with silica blebs (tuff?); some altered fragments nearly pure muscovite-kaolinite; trace schistose and cataclastic textures, trace gouge
7,270-7,280	a/a; 55% light greenish and brownish alteration products (includes very light green mica or chlorite) contains much white to brownish pearly muscovite; 40% white cryptocrystalline silicified rock; 5% recognizable volcanic fragments
7,280-7,290	a/a; minor recognizable volcanic fragments; 20% white cryptocrystalline TUFF(?); remainder highly altered rock with widely variable textures and mineral proportions a/a; common quartz veins; abundant muscovite-rich fragments with semi-schistose texture
7,290-7,300	a/a; 10% recognizable volcanic fragments; abundant vein quartz; abundant muscovite-rich fragments with occasional schistose texture
7,300-7,310	70% fine-grained black igneous rock (feldspar laths 1 mm or larger) with indistinct texture, contained feldspar and pyroxene(?) with abundant magnetite 30% altered volcanic rocks a/a
7,310-7,320	DIABASE, black, brownish black, feldspar laths 1-2 mm, interstitial pyroxene and magnetite; mostly very fresh, locally altered to brownish white clay

7,320-7,330	a/a; minor white clay alteration; common streaky and slickensided
7,330-7,340	a/a; very fresh; texture less ophitic
7,340-7,350	a/a; some very fine-grained fragments; minor white clay alteration, streaky in part; trace slickensides and greenish gouge; trace waxy green serpentine
7,350-7,360	a/a; appears highly fractured, abundant surfaces with dark green serpentine coating, occasionally with slickensides; minor serpentine alteration of rock; Note: this interval drilled very fast
7,360-7,370	a/a; mostly very fresh with vitreous appearance; trace serpentine on fractured surfaces
7,370-7,380	a/a; finer-grained, indistinct texture; minor whitish clay alteration; 10% white to light gray quartz-feldspar fragments
7,380-7,390	a/a; indistinct, variable, texture, generally finer-grained; minor whitish clay alteraton; trace slickensided surfaces; 30% white to grayish quartz-feldspar fragments, partly altered to kaolinite, zeolite, and calcite
7,390-7,400	70% white to grayish quartz-feldspar fragments (leucogranite?); texture indistinct and variable; feldspar mostly altered to muscovite, zeolite, and kaolinite; trace disseminated pyrite; no mafic minerals 30% brownish black DIABASE a/a
7,400-7,410	85% white to grayish and greenish quartz-feldspar (leucogranite?) fragments with trace biotite; feldspar partly altered to muscovite, zeolite(?) and kaolinite; much calcite present also as alteration product 15% brownish black DIABASE a/a
7,410-7,420	a/a; 95% LEUCOGRANITE; trace yellow-green epidote associated with rare biotite; much fine-grained brownish muscovite present; contained trace disseminated pyrite; minor kaolinization
7,420-7,430	a/a; nearly 100% LEUCOGRANITE; slight increase biotite with associated epidote; commonly splotchy greenish discoloration (due to chlorite?); common muscovite alteration of feldspar; contained disseminated calcite (alteration?); trace kaolinization
7,430-7,440	a/a; nearly 100% LEUCOGRANITE; increase biotite and associated epidote; 10% kaolinized fragments; Note: granite also contained tiny magnetite crystals

7,440-7,450	a/a; nearly 100% LEUCOGRANITE; ∿1% biotite plus magnetite, both with associated epidote; contained partial muscovite alteration of feldspar; ∿10% kaolinized fragments; trace sericitic sheared(?) GRANITE
7,450-7,460	90% LEUCOGRANITE, white to greenish and grayish; predominantly quartz and feldspar with trace biotite, epidote, muscovite (alteration product?); trace magnetite; trace kaolinite and zeolite alteration of feldspar; greenish discoloration possibly due to chloritization of biotite; trace disseminated pyrite; trace calcite as surface coatings and as disseminated alteration product 10% DIABASE and other fragments from up-hole
7,460-7,470	a/a; 20% slough
7,470-7,480	a/a; increase epidote and biotite; trace calcite-coated fracture surfaces; common disseminated pyrite
7,480-7,490	a/a; increase epidote and biotite
7,490-7,500	a/a; ∿1% epidote and biotite; contained trace kaolinized fragments
7,500-7,510	a/a
7,510-7,520	90% DIABASE, brownish black, crystals ∿1 mm, indistinct texture, possibly ophitic in part; contains plagioclase, pyroxene and magnetite; possibly same rock as above granite; minor local whitish clay alteration 10% LEUCOGRANITE a/a
7,520-7,530	a/a; slightly coarser-grained DIABASE; trace serpentine-coated fractured surfaces
7,530-7,540	a/a; coarser-grained (crystals common 2-3 mm); possibly contains some olivine
7,540-7,550	a/a; coarser-grained, contains common reddish brown vitreous interstitial mineral (rutile?); minor whitish clay alternation, otherwise very fresh
7,550-7,560	a/a; coaser-grained (2-3 mm crystals)
7,560-7,570	a/a; contained trace soft black serpentine(?) gouge, occasionally with slickensides
7,570-7,580	a/a; increase slickensided greenish black gouge (serpentine?); contained minor whitish clay alteration
7,580-7,590	a/a; common slickensided greenish black gouge; slight increase whitish clay alteration

7,730-7,740	a/a; relatively fresh; trace drusy quartz
7,740-7,750	a/a; increase biotite/chlorite/epidote; rock has "shattered" appearance; trace very fine-grained material with higher biotite content (possibly mafic inclusion)
7,750-7,760	a/a; increase biotite / epidote; ∿30% very fine-grained material with higher (and variable) biotite content (possibly mafic inclusions); contained "shattered" appearance; common kaolinization of all varieties.
7,760-7,770	a/a; minor very fine-grained biotite-rich variation Note: 20% sloughed fragments in this sample due to bit trip
7,770-7,780	a/a; slight increase biotite/chlorite/epidote Note: contained abnormal slough from trip
7,780-7,790	LEUCOGRANITE (continued), white grades to minor greenish and grayish, fine to medium-grained(?) with pervasive "shattered" (microfractured) appearance; contains quartz, feldspar (altered in part to muscovite, kaolinite, zeolite(?) and calcite), biotite (sparse), chlorite (after biotite), epidote (reaction between biotite and feldspar?); trace disseminated pyrite and magnetite; alteration (except kaolinization) probable deuteric
7,790-7,800	a/a; slight increase biotite/chlorite/epidote; slight increase kaolinization
7,800-7,810	a/a; slight increase biotite/chlorite/epidote; common kaolinized fragments
7,810-7,820	a/a; increase biotite/chlorite/epidote (2-3%?)
7,820-7,830	a/a
7,850-7,840	a/a; increase fine grained muscovite alteration of feldspar
7,840-7,850	a/a; trace drusy quartz fracture lining
7,850-7,860	a/a; trace tourmaline inclusions in quartz
7,860-7,870	a/a; magnetite occasionally in earthy aggregate
7,870-7,880	a/a; decrease microfractured appearance; trace soft greenish (clay?) alteration; Note: kaolinization has remained remarkably uniform (3-5% of samples)
7,880-7,890	a/a; decrease microfractured appearance; trace tiny tourmaline needles in quartz

7,890-7,900	LEUCOGRANITE (continued), white grades to minor grayish and greenish, fine to medium-grained with widesparead "shattered" appearance; contains quartz, feldspar (altered in part to muscovite, kaolinite, zeolite(?), and calcite), biotite (sparse), chlorite (after biotite), epidote (biotite-feldspar reaction?); trace yellow sphene(?), magnetite, pyrite, tourmaline; Note: some of quartz may be in veins
7,900-7,910	a/a
7,910-7.920	a/a; slight increase biotite/chlorite/epidote; decrease muscovite alteration of feldspar; contained miner kaolinization
7,920-7,930	a/a; slight increase biotite/chlorite/epidote; decrease alteration of feldspar
7.930-7,940	a/a; 10% kaolinized fragments; decrease muscovite alteration of feldspar
7,940-7,950	a/a; 15% kaolinized fragments
7,950-7,960	a/a; increase muscovite alteration of feldspar; 5% kaolinized fragments
7,960-7,970	a/a; contained widespread "shattered" texture; 10% kaolinized fragments
7,970-7,980	a/a; increase muscovite alteration of feldspar; trace tourmaline needles in quartz fragments; minor kaolinized fragments
7,980-7,990	a/a; increase muscovite alteration of feldspar; trace tourmaline needles in quartz fragments; 10% kaolinized fragments; Note: difficult to estimate amount of quartz in sample due to "shattered" texture, possibly very little
7,990-8000	a/a; increase alteration of feldspar; trace tourmaline needles in quartz fragments; trace very fine-grained biotite-rich fragments; 10% kaolinized fragments
8,000-8,010	a/a; abundant coarse biotite (in monomineral aggregate in part); very abundant cryptocrystalline to microcrystalline white and gray and brown crumbly muscovite-rich material
8,010-8,020	70% GRANITE, variable texture, abundant fine to coarse black biotite with associated epidote alteration, occasionally in monomineral aggregate; common black tourmaline needles included in coarse quartz (plus feldpsar?) grains 30% white, grayish, and greenish crumbly altered material with abundant quartz (veins and quartz-rich streaks) variable textures, includes some sheared-looking material; possible shear zone or granite contact zone

8,020-8,030	a/a; extremely heterogeneous cuttings; decrease biotite; increase light-colored crumbly micaceous altered material, streaky in part, calcic in part, silicified in part; abundant large quartz fragments, some with intergrown tourmaline crystals
8,030-8,040	80% DIABASE, greenish black, fine-grained (crystals to 1 mm) to aphanitic, contains plagioclase, pyroxene, magnetite; mild clay alteration to crumbly incompetent rock; trace serpentine alteration (gouge?); trace microcrystalline basalt; sparse plagioclase phenocrysts with very fine oriented hair-like inclusions 20% granite fragments, micaceous altered fragments and quartz aggregates
8,040-8,050	a/a; increase crumbly clay alteration; texture indistinct; trace microcrystalline BASALT; abundant vein quartz
8,050-8,060	a/a; nearly 100% DIABASE; decrease clay alteration and quartz veins; trace SERPENTINE
8,060-8,070	DIABASE, greenish black, mostly equigranular, crystals to 2 mm; contains plagioclase, pyroxene, magnetite; occasionally large feldspar phenocrysts (3-4 mm) with hair-like black inclusions; trace vein quartz and sheared material; trace which clay alteration of diabase; trace SERPENTINE
8,070-8,080	a/a; finer-grain (<1 mm crystals)
8,080-8,090	a/a; finer-grain, grades to microcrystalline; 30% light-colored crumbly micaceous altered material and minor vein quartz
8,090-8,100	80% heterogeneous cuttings, mostly light-colored, fine-grain, crumbly, altered (sheared?) material and lesser vein quartz; trace biotite-rich aggregate 20% DIABASE a/a
8,100-8,110	70% cryptocrystalline microcrystalline altered material, white to light greenish gray, mottled texture; soft, crumbly, contained predominantly chlorite and white clay (kaolinite?); trace vein quartz 30% fine-grained DIABASE, green-black, relatively fresh
8,110-8,120	a/a; 10% fine-grained DIABASE; very abundant quartz (veins and quartz-rich streaks); trace diaggregate coarse biotite flakes, association unknown
8,120-8,130	a/a; 5% fine-grained DIABASE; very abundant brownish black biotite, partly chloritized, associated with relatively coarse-grained green-black amphibole(?); contained abundant quartz

8,130-8,140	40% white to greenish gray altered material a/a; contained abundant quartz veins and intergrowths 30% DIABASE or BASALT 20% disaggregated coarse biotite flakes 10% coarse-grained hornblende-biotite (plus minor feldspar?) rock Note: Hornblende-biotite rock appears in place before alteration occurred
8,140-8,150	95% altered rock, white to greenish gray, predominantly extremely fine-grained, mostly crumbly chlorite and kaolinite with common quartz veins and intergrowths 5% DIABASE/BASALT and lesser hornblende-biotite-feldspar fragments; trace disaggregated coarse biotite flakes
8,150-8,160	a/a; trace hornblende-biotite rock; trace large (4 mm) plagioclase phenocrysts; Note: first sample after trip
8,160-8,170	40% hornblende-biotite-feldspar amphibolite, green-gray, medium(?)-grained, includes 10% disaggregate coarse biotite flakes; much altered to light green-gray chlorite 30% relatively fresh DIABASE a/a 20% white quartz and feldspar fragments with some associated biotite/chlorite/epidote/pyrite 10% white to light gray crumbly altered material a/a
8,170-8,180	70% hornblende-biotite-feldspar amphibolite, green-black, medium-grained with minor alteration to green-gray chlorite; contains trace euhedral apatite and disseminated calcite 30% DIABASE and altered material a/a
8,180-8,190	a/a; 90% AMPHIBOLITE; increase alteration; trace calcite veins; trace intergrown epidote
8,190-8,200	a/a; 90% AMPHIBOLITE; decrease biotite, increase epidote; much of amphibole is now actinolite; trace quartz veins
8,200-8,210	a/a; 90% AMPHIBOLITE; both hornblende and actinolite are present; decrease biotite; trace calcareous veins; trace chlorite alteration
8,210-8,220	Nearly 100% hornblende-actinolite-biotite AMPHIBOLITE (continued), gray-green to green-black, fine to medium grained; trace yellow sphene(?) and white apatite prisms; trace calcareous veins; trace chlorite alteration; trace diabase fragments; trace crumbly white to gray bleached alteration
8,220-8,230	a/a; increase alteration and calcareous veining; biotite turning brown
8,230-8,240	a/a; 30% black aphanitic microprophyry (plagioclase phenocrysts) igneous rock, contained brown biotite and common vitreous brown alteration of amphiboles

8,240-8,250 70% black aphanitic igneous rock a/a, grades to fine-grained diabase
30% partly altered AMPHIBOLITE a/a

8,250-8,260 Altered and silicified interval:
50% silicified fragments (vein quartz plus quartz intergrowths in whitish altered rock); trace chlorite alteration
40% AMPHIBOLITE
10% DIABASE (aphanitic to fine-grained)
Note: this sample contained much slough from higher in hole

8,260-8,270 95% AMPHIBOLITE, deep gray-green, fine to medium grained, contains predominantly biotite and green amphibole with less well-developed cleavage than above; trace brownish and greenish waxy sheared material
5% black aphanitic to fine-grained DIABASE

8,270-8,280 95% AMPHIBOLITE with variable, often indistinct texture, contains actinolite, hornblende (minor), biotite, chlorite(?), trace feldspar; trace waxy polished shear surfaces; trace calcareous veins; possibly grades to
5% black aphanitic to fine-grained HORNFELS(?)
Note: sample gives impression through textural and mineralogical variability of incomplete recrystallization of mafic igneous rock

8,280-8,290 a/a; even broader textural and mineralogical gradation between aphanitic black rock and amphibolite; incomplete recrystallization

8,290-8,300 a/a; 100% AMPHIBOLITE; trace epidote; trace fractured or sheared surfaces coated with serpentine(?); trace greenish and brownish talc-like sheared material

8,300-8,310 a/a; 100% AMPHIBOLITE

8,310-8,320 a/a; 100% AMPHIBOLITE

8,320-8,330 AMPHIBOLITE (continued), grayish green, fine-grained, contains actinolite, biotite, chlorite, magnetite, trace hornblende; trace fine-grained brown micaceous mineral (alteration product?), trace clayey white to greenish clay alteration; trace talc-like sheared material

8,330-8,340 a/a; some fragments with interstitial black aphanitic material (unrecrystalized basalt?); slight increase talc-like sheared material; trace fresh BASALT and/or DIABASE

8,340-8,350 a/a; AMPHIBOLITE grades to minor slightly biotitized BASALT(?); common whitish to greenish talc-like sheared material; trace soft light greenish fibrous mineral

8,350-8,360	a/a; grades to minor slightly biotitized basalt(?), minor mild alteraton (bleaching) to fine-grained white substitute (kaolinite?) Note: actinolite becoming lighter-colored
8,360-8,370	a/a; grades to trace slightly biotitized basalt(?)
8,370-8,380	a/a; trace calcarous veins; common fine-grained yellow-brown micaceous mineral in clumps (chlorite variation? phlogopite? margarite?)
8,380-8,390	a/a; common incipient greenish white clay alteration; common yellow-brown micaceous mineral
8,390-8,400	AMPHIBOLITE (continued), medium to dark gray-green, fine-grained, contains green actinolite, brownish black biotite, trace black hornblende, trace yellow-brown micaceous mineral in fine-grained clots (possibly retrograde alteration of actinolite), chlorite, magnetite; minor greenish white clay alteration; trace talc-like sheared material
8,400-8,410	a/a
8,410-8,420	a/a; slight increase clay alteration and shearing
8,420-8,430	a/a; decrease yellow-brown micaceous mineral; increase clay alteration and shearing
8,430-8,440	a/a
8,440-8,450	a/a; abundant greenish white clay alteration; decrease yellow-brown micaceous mineral
8,450-8,460	a/a; poorly defined texture; increase brown biotite; decrease well formed amphibole crystals; very abundant disseminated magnetite; possibly less recrystalized
8,460-8,470	a/a; poorly defined mottled texture with abundant large brown biotite crystals; increase clay alteration and shearing
8,470-8,880	a/a; many fragments only partly recrystallized, contains jet black aphanitic matrix (basalt?); common clay alteration and talc-like sheared material
8,480-8,490	same as 8,470-8,480 feet
8,490-8,500	Partly metamorphosed BASALT(?), gray-green to black, aphanitic to fine-grained; actinolite, biotite, and chlorite crystalizing from jet-black aphanitic material (~40%) contains much magnetite, occasionally with hint of relict volcanic texture; abundant greenish white clay alteration (chlorite in part?) and talcy sheared material

	Note: biotite is first mineral to grow large crystls; black aphanitic material appears to be incipient recrystalization to amphibole
8,500-8,510	a/a
8,510-8,520	a/a; slight decrease in alteration and shearing
8,520-8,530	a/a; decrease black aphanitic material; contained abundant greenish clay alteration; trace SERPENTINE
8,530-8,540	a/a; very little black aphanitic material; predominantly green actinolite-biotite AMPHIBOLITE; contained abundant greenish clay alteration; Note: this sample contains much slough and fibrous pump-packing material
8,540-8,550	AMPHIBOLITE, gray-green, fine-grained with variable? poorly defined texture, contains actinolite, biotite, magnetite; abundant greenish clay (plus chlorite?) alteration; common talc-like sheared material; trace quartz veins; common black aphanitic poorly recrystalized material; Note: sample contains much slough from higher in hole (10-15%) and fibrous pump-packing material
8,550-8,560	a/a; 30% slough (very large fragments)
8,560-8,565 (Total Depth)	a/a; contained abundant clay alteration; contained much slough

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Appendix B

Temperature Logs for USA #11-36

Temperature Log #1

Hole: Depth - 8,565 feet
Diameter - 12-1/4 inches
Casing - 13-3/8 inches/2,701 feet

Instrument: Serial No. 113
Element Range - 100°-580°F
Clock: 12 hr-7-1/2 turn

Halt circulation: 8:50 AM, 6/28

First stop: 1:02-1:12 PM, 6/28, depth 5,000 ft; stabilization 4 hours 22 minutes

On bottom: 3:29-3:49 PM, 6/28; stabilization time 6 hours 59 minutes

Description: 9 minute stops, 20 minutes on bottom

Depth (ft)	Temperature (°F)
5,000	186.1
5,500	189.7
5,750	191.2
6,000	192.6
6,250	193.1
6,500	197.3
7,000	199.8
7,500	199.0
8,000	200.8
8,300	203.4
8,500	205.5
8,575	216.4

Temperature Log #2

Hole: Depth - 8,565 feet
Diameter - 12-1/4 inches
Casing - 13-3/8 inches/2,701 feet

Instrument: Serial No. 113
Element Range - 100°-580°F
Clock: 12 hr-7-1/2 turn

Halt circulation: 8:50 AM, 6/28

First stop: 8:44-8:54 AM, 6/30; depth 5,000 feet; stabilization 48 hours 4 minutes

Last stop: 11:44-12:14 PM, 6/30; depth 8,575 feet; stabilization 51 hours 24 minutes

Description: 9 minute stops, 20 minutes on bottom

Depth (ft)	Temperature (°F)
5,000	209.3
5,500	215.4
5,750	218.7
6,000	224.0
6,250	226.9
6,500	230.3
7,000	230.3
7,500	230.1
8,000	237.5
8,300	240.4
8,500	253.3
8,565	255.4

Temperature Log #3

Hole: Depth - 8,565 feet
Diameter - 12-1/4 inches
Casing - 13-3/8 inches/2,701 feet

Instrument: Serial No. 113
Element Range - 100°-580°F
Clock: 12 hr-7-1/2 turn

Halt circulation: 8:50 AM, 6/28

First stop: 6:30-6:40 PM, 6/30; depth 500 feet; stabilization 81 hours 50 minutes

Last stop: 1:46-1:56 AM, 7/1; depth 8,526 feet; stabilization 89 hours 6 minutes

Description: continuous traverse, 20 feet/minute, 500 feet to total depth; 10-minute stops at 500 feet and bottom.

Depth (ft)	Temperature (°F)

(see attached)

SURVEY TRAVERSED 20' PER MINUTE.

Chuck Skenfield

SURVEY DATA

DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.
500	124.63	1840	156.21	3180	185.05	4520	200.21	5860	224.21	7200	233.05
520	125.26	1860	156.21	3200	185.47	4540	200.42	5880	225.05	7220	233.05
540	126.53	1880	156.21	3220	186.11	4560	200.63	5900	226.11	7240	233.05
560	127.16	1900	156.42	3240	186.53	4580	201.05	5920	226.74	7260	233.05
580	127.58	1920	156.84	3260	186.74	4600	201.89	5940	227.37	7280	233.05
600	128.00	1940	157.05	3280	186.95	4620	203.16	5960	228.21	7300	233.26
620	128.42	1960	157.68	3300	187.16	4640	204.42	5980	228.84	7320	233.26
640	128.84	1980	158.11	3320	187.37	4660	205.68	6000	229.26	7340	233.26
660	129.26	2000	158.95	3340	187.79	4680	206.74	6020	229.47	7360	233.26
680	129.68	2020	158.95	3360	188.00	4700	207.79	6040	229.68	7380	233.26
700	130.32	2040	159.16	3380	188.21	4720	208.63	6060	229.89	7400	233.26
720	130.74	2060	160.21	3400	188.42	4740	209.47	6080	230.11	7420	233.47
740	131.16	2080	161.05	3420	188.63	4760	210.11	6100	230.32	7440	234.11
760	131.58	2100	161.47	3440	188.84	4780	210.53	6120	230.53	7460	234.74
780	132.00	2120	162.11	3460	189.05	4800	210.53	6140	230.74	7480	234.95
800	132.42	2140	162.53	3480	189.26	4820	210.74	6160	230.95	7500	234.95
820	132.63	2160	162.95	3500	189.47	4840	210.95	6180	230.95	7520	234.95
840	133.05	2180	163.79	3520	189.68	4860	211.37	6200	231.16	7540	234.95
860	133.47	2200	164.42	3540	190.11	4880	211.58	6220	231.37	7560	234.95
880	133.89	2220	164.63	3560	190.11	4900	212.00	6240	231.58	7580	234.32
900	134.32	2240	164.84	3580	190.32	4920	212.21	6260	231.79	7600	234.32
920	134.74	2260	165.05	3600	190.74	4940	212.42	6280	231.79	7620	234.32
940	135.37	2280	165.47	3620	191.16	4960	212.63	6300	232.00	7640	234.53
960	136.00	2300	165.68	3640	192.00	4980	212.84	6320	232.00	7660	234.95
980	136.63	2320	166.11	3660	192.84	5000	213.05	6340	232.21	7680	235.58
1000	137.26	2340	166.32	3680	193.26	5020	213.25	6360	232.21	7700	236.00
1020	138.32	2360	166.53	3700	193.47	5040	213.47	6380	232.42	7720	236.84
1040	138.95	2380	166.95	3720	193.89	5060	213.47	6400	232.42	7740	237.47
1060	139.37	2400	167.37	3740	194.11	5080	213.68	6420	232.42	7760	238.32
1080	139.79	2420	167.79	3760	194.32	5100	213.89	6440	232.42	7780	238.74
1100	140.21	2440	168.21	3780	194.32	5120	214.11	6460	232.42	7800	239.37
1120	140.84	2460	168.84	3800	194.74	5140	214.32	6480	232.42	7820	240.11
1140	141.05	2480	169.57	3820	195.16	5160	214.32	6500	232.42	7840	240.21
1160	141.47	2500	170.11	3840	195.16	5180	214.53	6520	232.42	7860	240.42
1180	141.89	2520	170.74	3860	195.16	5200	214.74	6540	232.42	7880	240.42
1200	142.11	2540	170.95	3880	195.16	5220	214.95	6560	232.42	7900	240.63
1220	142.53	2560	171.37	3900	195.16	5240	215.16	6580	232.42	7920	241.05
1240	143.37	2580	171.79	3920	195.16	5260	216.21	6600	232.42	7940	241.26
1260	144.21	2600	172.00	3940	195.37	5280	217.68	6620	232.42	7960	241.68
1280	144.42	2620	172.42	3960	195.37	5300	218.74	6640	232.42	7980	241.89
1300	144.63	2640	172.63	3980	195.58	5320	219.37	6660	232.42	8000	242.11
1320	144.63	2660	172.84	4000	195.79	5340	220.00	6680	232.42	8020	242.11
1340	144.84	2680	173.26	4020	196.00	5360	220.63	6700	232.42	8040	242.11
1360	145.26	2700	173.68	4040	196.21	5380	220.63	6720	232.42	8060	242.11
1380	145.68	2720	174.53	4060	196.21	5400	220.63	6740	232.63	8080	242.11
1400	146.11	2740	175.16	4080	196.42	5420	220.84	6760	233.05	8100	242.11
1420	146.53	2760	176.00	4100	196.63	5440	220.84	6780	233.05	8120	243.58
1440	146.95	2780	176.42	4120	196.63	5460	220.84	6800	233.05	8140	244.85
1460	147.58	2800	176.84	4140	197.05	5480	221.05	6820	233.05	8160	245.26
1480	148.00	2820	177.26	4160	197.68	5500	221.05	6840	233.05	8180	245.26
1500	148.63	2840	177.26	4180	197.89	5520	221.05	6860	233.05	8200	246.53
1520	149.05	2860	177.47	4200	198.11	5540	221.05	6880	233.05	8220	246.95
1540	149.26	2880	177.89	4220	198.11	5560	221.26	6900	233.05	8240	247.37
1560	149.68	2900	178.74	4240	198.11	5580	221.26	6920	233.05	8260	247.58
1580	150.11	2920	179.37	4260	198.32	5600	221.26	6940	233.05	8280	248.00
1600	150.53	2940	180.00	4280	198.53	5620	221.26	6960	233.05	8300	248.21
1620	151.16	2960	181.05	4300	198.53	5640	221.47	6980	233.05	8320	248.63
1640	151.58	2980	181.68	4320	198.74	5660	221.47	7000	233.05	8340	249.05
1660	151.79	3000	182.53	4340	198.95	5680	221.47	7020	233.05	8360	249.47
1680	152.42	3020	182.95	4360	198.95	5700	221.47	7040	233.05	8380	249.89
1700	152.63	3040	183.58	4380	199.16	5720	221.68	7060	233.05	8400	250.32
1720	153.05	3060	184.00	4400	199.37	5740	221.68	7080	233.05	8420	251.16
1740	153.26	3080	184.21	4420	199.37	5760	221.68	7100	233.05	8440	252.42
1760	153.89	3100	184.42	4440	199.58	5780	221.89	7120	233.05	8460	254.32
1780	154.53	3120	184.63	4460	199.79	5800	221.89	7140	233.05	8480	255.37
1800	155.37	3140	184.63	4480	199.79	5820	222.32	7160	233.05	8500	257.05
1820	155.79	3160	184.63	4500	200.00	5840	223.16	7180	233.05	8526	258.11

124.03 − 258.11 = 134.05 °F / 8026 ft

1.6705 °F/100 ft

30.40 °C/km

PLATE II-36 Casing program and lithologic, temperature and penetration data for USA No. 11-36

CASING

20" — 320'

13-3/8" — 2,701'

12-1/4" — T.D. 8,565'

LITHOLOGY

DEPTH (FEET)

0
- Precipitation of silica and calcite from warm ground water (outflow from Leach Hot Springs?). Almost no other alteration of the original sediments.
- Alluvium: variable mixtures of poorly consolidated clay, sand and gravel; partially silicified in upper 600 feet, reaching maximum intensity at about 300 feet; calcareous in upper 100 feet, well developed "tube" structure in silicified sediments.

500

1,000

1,500
- Widespread small-scale shearing throughout the Tertiary sediment section, evidenced by slickensided surfaces. No major shear zones recognized
- Mudstone and claystone, predominantly light greenish gray, moderately consolidated, calcareous, locally sandy and gravelly.

2,000
- Predominantly sand and gravel with variable light brown to light gray silty clay matrix and interbeds

2,500
- Mudstone and claystone, predominantly light green-gray, generally well consolidated, calcareous and commonly sandy, occasional interbeds of clay-cemented sand and gravel; tuffaceous in part.

3,000

3,500
- Tuffaceous sandstone, siltstone, and conglomerate, poorly sorted, locally silicified.
- Predominantly mudstone, siltstone, gray green to light green to light brown and gray, calcareous, locally sandy, partly tuffaceous, well consolidated; contains disseminated calcite euhedra and some secondary pyrite.

4,000

4,500
- Tuffaceous sandstone, conglomerate and siltstone, moderately to well consolidated, locally slightly altered and partially silicified

5,000
- Pervasive mild clay/chlorite alteration of basalt/andesite, probably old; no sign of open fractures.
- Basalt and andesite, mostly containing plagioclase and sparse pyroxene(?) phenocrysts. Mildly altered and crumbly rocks.
- Silicic tuffs and tuffaceous sediments, red-brown, gray, gray-brown and greenish, non-welded, locally crystal rich.
- Mixed claystone, sandstone and conglomerate, clasts predominantly silicic tuffs and cryptocrystalline rhyolite and/or chert.

Erosional Unconformity — TERTIARY

TRIASSIC

5,500
- Heavily stained by hematite in upper part due to weathering
- Rhyolitic rocks, predominantly white and pastel colors, cryptocrystalline to microcrystalline, variable textures, altered phenocrysts of feldspar and mica, possibly includes lithic tuffs.
- Slight sericite(?) alteration at base of unit.
- Granite, white, fine-grained, with quartz, feldspar and green and brown mica.
- Mafic volcanic rocks, variably recrystallized to biotite-hornblende-epidote rock, locally intensely metasomatized to quartz-feldspar-mica rock.

6,000
- Traces of drusy quartz-coated fracture surfaces, possibly precipitated by hydrothermal fluids. However, the bulk of the quartz in this rock is intergrown with biotite, chlorite, muscovite and feldspar, evidently crystallized under metasomatic conditions.
- Metasomatized rock, white to greenish, fine-grained to extremely fine-grained, consisting of quartz, feldspar, biotite, chlorite and muscovite in varying proportions, with local traces of epidote, hornblende and ubiquitous disseminated pyrite; texture extremely erratic.

6,500

7,000
- 50-bbl mud loss, 7,137'
- Altered (metasomatized) mafic volcanic rocks and interbedded white tuff.
- Increased sericite(?) alteration near diabase contact.
- Diabase/gabbro, brownish black, with chilled margins; contains labradorite, pyroxene, magnetite and possible rutile.
- Leucogranite, white to light gray, fine- to medium-grained, containing primary quartz, feldspar, biotite and magnetite and secondary chlorite, muscovite, epidote, pyrite, kaolinite and possible zeolite.

7,500
- Diabase/gabbro, brownish black, coarse-grained with chilled margins; contains labradorite, pyroxene, magnetite and possible rutile.
- Continued traces of drusy quartz lining cavities or fracture surfaces.
- Leucogranite, white to light gray, fine- to medium-grained, containing primary quartz and feldspar, biotite and magnetite, with widespread deuteric alteration to secondary chlorite, muscovite, epidote, zeolite(?) and pyrite; trace tourmaline intergrown with vein quartz.

8,000
- Metasomatized contact zone.
- Diabase, brownish black, fine- to medium-grained with chilled margins.
- Altered and silicified biotite amphibolite.
- Diabase as above.
- Actinolite-biotite-hornblende amphibolite, green-black, fine-grained.
- Diabase, very fine-grained.
- Decrease in degree of recrystallization with depth below granite contact.
- Hornblende-biotite-actinolite amphibolite, gray-green, fine-grained, with accessory apatite and magnetite; metamorphic grade decreases irregularly with depth.

8,500

TEMPERATURE DATA

TEMPERATURE (°F)

60 80 100 120 140 160 180 200 220 240 260

DEPTH (FEET)

0 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 4,500 5,000 5,500 6,000 6,500 7,000 7,500 8,000 8,500

- Mud in
- Mud out
- Mud cooler turned on
- Measured bottom-hole temperature on directional surveys (0-220°F MRT)
- Post-drilling temperature logs
  - No. 1 6/28
  - No. 2 6/30
  - No. 3 6/30-7/1
- 7 hours post-circulation
- 51-1/2 hours post-circulation
- 69 hours post-circulation
- 0-220°F MRT
- 200-500°F MRT

TEMPERATURE (°F)

60 80 100 120 140 160 180 200 220 240 260

PENETRATION RECORD

DATE

MAY | JUNE | JULY

15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3

5 10 15 20 25 30 35 40 45

NUMBER OF DAYS OF DRILLING

DEPTH (FEET)

0 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 4,500 5,000 5,500 6,000 6,500 7,000 7,500 8,000 8,500

- Set 20" casing
- Set 13-3/8" casing
- Bit trip
- Twist off
- Logging, Plugging Abandoning

NUMBER OF DAYS OF DRILLING

15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3

5 10 15 20 25 30 35 40 45

MAY | JUNE | JULY

DATE

AMINOIL USA, INC.
HOUSTON, TEXAS

USA 11-36

CASING PROGRAM, LITHOLOGIC LOG
TEMPERATURE SURVEYS &
DRILLING TIME CURVE

SCALE	CITY	DATE	FIG. NO. 9
INTERPRETATION		DRAFTING	FILE NO.